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THE

CAUSATION AND PREVENTION

OF

DISEASE.

BY JOHN PARKIN, M.D.,

LATE MEDICAL INSPECTOR FOR CHOLERA IN THE WEST INDIES.

LONDON:

JOHN CHURCHILL, NEW BURLINGTON-STREET.

1839.

B

[*The Author reserves to himself the right of translating this work.*]

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TO

THE METROPOLITAN BOARD OF WORKS.

This Treatise is inscribed, in the hope that the facts contained therein may prove of service in the determination of that important question, which has been left, by the Legislature and the Government, to the decision of the Board.

J. PARKIN.

ROME, 1858.

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ERRATA.

In consequence of my absence from England while the work was passing through the press, a greater number of errors have remained uncorrected than would otherwise have been the case. I must therefore request the reader to correct these, before commencing; particularly as all minor and typographical errors—those that would be apparent at sight—have not been noticed.

It is right to add also, that, in consequence of my not having access to any public library, at the time of my writing the present Treatise, some of the references to works and authors quoted could not be given.

Page 1, last line but four, for 1820, read 1830.
P. 7, l. 25, for *do*, read *does*.
P. 9, l. 8, for *from*, read *during*.
P. 13, l. 19, for *Thœuet*, read *Thouet*.
P. 16, l. 24, for *malaria*, read *malaise*.
P. 18, l. 7, for *from the dilution*, read *from dilution*.
P. 24, l. 23, for *men*, read *man*.
P. 25, l. 20, for *have*, read *had*.
P. 26, l. 16, for *that*, read *those*.
P. 28, l. 3, for *Mysten*, read *Nysten*.
P. 31, l. 6, for *marked*, read *morbid*.
P. 38, the author of the work alluded to, at the foot of the page, is Orfila.
P. 40, last line but one, for *Jannes*, read *Jonnes*.
P. 45, l. 18, for *Yaurts*, read *Yourts*.
P. 46, last line but one, for 10 *acres*, read *the acre*.
P. 51, l. 6, for *during the 17th century*, read *during the first part of the 17th century*.
P. 56, l. 22, for *was*, read *is*.
P. 58, l. 18, for *purity*, read *impurity*.
P. 65, l. 7, instead of . *For instance*, read ; *as for instance*.
P. 66, l. 1, for *one*, read *only*.
P. 68, l. 1, for *their theory*, read *their otherwise defenceless theory*.
P. 68, l. 6, for *it*, read *leaven*.
P. 69, l. 23, for *waters*, read *matter*.
P. 71, l. 11, for *those*, read *these*.
P. 79, last line but three, for *universal*, read *unusual*.
P. 81, l. 4, for Sir G. *Beane*, read Sir G. *Blane*.
P. 82, l. 26, for *Laucise*, read *Lancisi*.
P. 83, l. 11, for *malarian*, read *malarious*.
P. 88, l. 3, for *that it possesses*, read *this is, that it possesses*.
P. 88, l. 5, for *emitted with*, read *united with*.
P. 92, l. 5, the sentence should be thus:—"If the malarious tract be situated on one side of the stream only, those living on the opposite side," &c., &c.

P. 95, l. 15, for *just*, read *before*.
P. 97. The asterisk, at line 8, should be placed at the first line, after the word *marais*.
P. 104, l. 8, for *not been*, read *not been seen*.
P. 106, l. 3, for *from epidemic*, read *from epidemic diseases*.
P. 110, l. 27, for *offered*, read *afford*.
P. 111, l. 5, for *the*, read *this*.
P. 113, l. 29, for *as*, read *or*.
P. 114, last line but one. *For the prevention of the disease*, read *prevention of disease*.
P. 119, last line but four, for *ever*, read *even*.
P. 124, l. 22, for *I have offered*, read *I have heard offered*.
P. 127, l. 12, for *cholera*, read *fever*.
P. 127, l. 18, for *cautiously*, read *continuously*.
P. 130, l. 8, for *sought*, read *taught*.
P. 130, l. 28, for Professor *Cleary*, read Professor *Way*.
P. 150, l. 23, for *Broechi*, read *Brocchi*.
P. 151, last line, for *making*, read *masking*.
P. 153, last line, for *chemical*, read *clinical*.
P. 153, note, line 4, for *this*, read *the*. This note refers to a previous passage, and to the word *deodorizer*.
P. 154, note, line 15, for . *There were*, read , *that there were*.
P. 164, first line, for *Dr. Acton*, read *Dr. Aiton*.
P. 166, l. 29, for *combination*, read *combustion*.
P. 176, l. 27, to *at* 10*l. a-ton*, add , *the price of guano*.

INTRODUCTION.

It is necessary to observe, that it is not my intention to enter into a discussion of all the causes that are, or may be, productive of disease, for this would require an elaborate and extended inquiry, particularly if it embraced every class of disease,—external and internal, as well as those produced from extrinsic and intrinsic causes. If we exclude the external or surgical diseases, as also those produced by intrinsic or individual causes, there will remain those that are ascribed to the operation of extrinsic, or general causes. Such an inquiry would necessarily embrace the two classes of disease termed epidemics and endemics; but it will be unnecessary to enter into a discussion of either the cause or the prevention of the former class, as I have already devoted a work to a consideration of the cause, while the means of prevention have been pointed out in two Reports—one published,* the other unpublished. The latter Report, which also contains a collection of important facts on the predisposing causes of the epidemic cholera, was presented by me to the Secretary of State for the Colonies, on my return from the West Indies in 1855. Unless, therefore, for the purpose of illustration, or while discussing the opinions and theories of others, my remarks, on the

* Statistical Report of the Epidemic Cholera in Jamaica.

present occasion, will apply more particularly to endemic diseases.

As the subject is a public one, it may be as well to mention the circumstances that have hitherto prevented the appearance of the latter Report. Having urged its publication on the authorities at the Colonial Office, it was by them referred to the General Board of Health, for their consideration and opinion. Although the answer has not been communicated to me officially, or in writing, I have been given to understand that the Board recommended the Report *not* to be published, excepting under circumstances that are not likely to be realized. The reasons assigned were, that my conclusions are not only opposed to those of the Board of Health, but, also, to the experience of the day; and that the publication of my opinions would be detrimental to the cause of Sanitary Reform.

That my conclusions are different from those of the Board of Health is an undoubted fact: nothing, in fact, can be more opposed. The Board states, that certain causes predispose to and produce the epidemic cholera, and that the removal of these causes will prevent its return, or lessen its ravages, and shorten its duration, when present. I, on the contrary maintain that the theory of the Board of Health is false and untenable, and that the measures hitherto proposed and adopted by that Board, will neither prevent the return of this modern plague, nor mitigate its ravages, when present, in the *slightest degree.* But the Board remarks, that these conclusions are at variance with the recognised opinions and experience of the day. This I deny. My conclusions are not opposed to the experience of the day, but merely to the opinions and theory of a certain class of writers, of whom the Board of Health has hitherto been the patron and the advocate. The theory

of these writers, as regards the epidemic cholera, has been formed from the facts collected during the prevalence of this disease in England, and during two visitations only: mine, on the contrary, is the result of a study of all the phenomena that have been presented to our notice, from the first outbreak in 1817 to the present day, and in all climates and latitudes—in the intertropical regions of the East and the West; on the burning sands of Arabia, and on the snow-covered steppes of Russia, as well as in the temperate regions of Europe and America. More than this, these phenomena are similar to those that have been recorded since the practice of medicine was a science—from the time of Hippocrates to the present day: and more particularly, during the prevalence of the Black Death of the 14th century. While, therefore, the theory of the Board of Health, rests merely on a few isolated facts, obtained in one locality, and during two visitations only of the epidemic cholera, mine, on the contrary, is founded, not only on the experience of the day, but, on the experience of ages, and will therefore remain, when that of my opponents is forgotten, or, merely remembered as "a tale that is told."

Another argument of the Board of Health is, that my opinions and conclusions, if made known and disseminated, would arrest the march of what has been termed Sanitary Reform. Nothing can be more erroneous than such an assertion. Not only have I expressed myself, in that very Report, to be a strong advocate of Sanitary Reform, in the proper signification of the term, —for the physical and social welfare of the lower orders is intimately connected with this measure,—but, as will be seen hereafter, I should go much farther than these pretended reformers. True, I should not attempt to deceive the public, by inducing them to adopt Sanitary

Reform for other than its legitimate objects: believing that if, after the adoption of measures ostensibly carried out for the prevention of the epidemic cholera, the disease should return and should prevail in a more aggravated form than before, which will probably be the case, it would be the means of retarding, rather than promoting that cause, which I, in common with every well wisher of his species, have at heart.

The question, however, lies not here. The real motives for the opposition of the Board of Health are, that I have condemned not only their theory, but their measures. That, however, ought to be no reason for the suppression of my Report, but the reverse. If the measures proposed by this so-called Board of Health be the true ones, no harm can result from any strictures thereon, made by me, or others. Truth, like the spark which lights up the beacon to guide the wanderer on his way, is only elicited by the concussion of opposing bodies; my criticisms, therefore, would have the opposite effect to that so much dreaded by the Board of Health. On the other hand, if those measures be improper, or useless, the sooner the fact be made known the better: otherwise we shall be reposing on a staff that will snap asunder in the hour of trial and of danger, and pierce us probably to the heart, instead of being our support and salvation. The Board of Health, however, thought otherwise, and the result of the discussion was, that my Report was not ordered to be printed by the Colonial Secretary. Of that decision I have no right to complain, particularly as I have always received every attention from the authorities at the Colonial Office, as well as their thanks for the services rendered by me during my late mission to the West Indies. I would merely observe, that the Board of Health is no authority in medical matters; as at present consti-

tuted, it is simply a Board of Works, with a medical adviser attached to it. Any medical opinion, therefore, emanating from that Board must be taken as the opinion of a single individual, and its value, consequently, will depend on his reputation, his knowledge, and his experience. Were the Board, however, a strictly medical or scientific one, that would not have altered their position or mine. It is, I humbly submit, the duty of such a Board—the professed guardians of the public health, appointed by the Government, and paid by the public—not only to receive, but to weigh and to consider the opinions, conclusions, and proposals of others, the object of which is the public weal,—throwing aside, for the moment, all preconceived theories, opinions, and prejudices. This was the more necessary, when a vast and expensive project was in contemplation, based on a theory that the facts and arguments in my Report tended to overthrow. But, if they did not choose to do this, the Board should, at all events, have allowed others—the Government and the public at large—to form their opinion and conclusions on the subject. The Board of Health, however, well knew that my facts and my arguments cannot be set aside, or controverted, and, as such, they were anxious to keep afloat, for as long a time as possible, the crazy and sinking vessel to which they have clung; for a more absurd and illogical theory, in order to account for the production of disease, has never been propounded since medicine was a science—as it will be my object to show on the present occasion. But the Board of Health has strangely mistaken both its office and its power; its decision in medical questions is neither final nor of any value. There is another and more powerful body, whose judgment is unerring and whose verdict is binding—the profession to which I belong: to this

tribunal I now appeal, waiting with confidence and resignation its decision on the question.

In the meantime, I again call on the Secretary of State for the Colonies to order that Report to be printed, not only for the reasons already assigned, but, also, because it contains other matters of peculiar interest and importance to our West India possessions. One is, the presumed importation of the epidemic cholera into St. Thomas and Nevis: a subject that I took some pains to investigate, and on the right understanding of which will depend the fact, whether quarantine is to be established in the British West India Islands, during future visitations of this disease, the same as during the last. Another matter is, an inquiry into the causes of the high rate of mortality that occurred among the black population in the West India colonies; with suggestions for its prevention—a subject of vital importance to these islands, if they are to be ravaged by this modern scourge, during future years, as India has been during the past. I say nothing respecting the measures proposed by me for the prevention of the epidemic cholera—and which I believe to be the only ones capable of accomplishing this object—having entered into that subject on a previous occasion, although not so fully.

It is not for me to anticipate the decision of those placed in authority; I will therefore only add, that, having no personal interest or motive in the publication of that Report, I shall leave the responsibility of its suppression, or its publication, in the hands of those whom it more immediately concerns—Her Majesty's Government.

PART I.

It may, perhaps, appear to some a work of supererogation to enter into a discussion of the causation of disease, when a particular theory has been lately propounded, which, if not the recognised one, has at least taken a firm hold of the public mind, as well as of a considerable part of the profession in England. It will be as well, however, to ascertain what this theory really is, and the evidence that has been advanced in support of its doctrines and conclusions—particularly as this theory is, in my opinion, a very erroneous one. Such an inquiry is desirable, not only in a theoretical, but, also, in a practical point of view; and especially at the present moment, when measures are being generally adopted for the prevention of disease, based on the conclusions drawn from that theory; for, if the premises on which it is founded are false, the measures, in all probability, will be improper and useless.

It is Dr. Southwood Smith who may be said to have laid the foundation of this modern theory, the first notice of which is to be found in his work on Fever, published in 1820, and in which he thus expresses himself:—"The immediate, or the exciting cause of fever is a poison formed by the corruption or the decomposition of organic matter." Drs. Arnott and Kay, at a later period, express

themselves in nearly similar terms. The former observes: —"In many situations on earth, where there is going on the putrefaction or decomposition of animal and vegetable substances, and, often, in proportion to the amount of this, there arises into the air an exhalation now called Malaria, which produces the state now called Fever." * Had these writers stopped here, we might have concluded that they were referring to a theory which, as will be hereafter shown, was the general and recognised one, in order to account for the production of endemic fever, both in temperate and tropical climates. But the further development of their opinions, and of those who followed in the same track, soon showed that there were some very important differences between the theory of former writers and these modern ones. In the first place, endemic diseases alone were previously supposed to be the products of malaria, but epidemics are also referred to the same cause by the last-named theorists. "The same conditions," as we are informed by Mr. Grainger, "which either favour or control the spread of fever, promote or oppose the ravages of cholera." And, again:— "With respect to the more specific, or eruptive fevers, as scarletina and measles, they only flourish, as to the rule, amidst the filthy and neglected dwellings of the poor, where they acquire a malignity which gives them almost a new character." † I had always thought, in my simplicity, that the children of all classes—from the Queen on her throne to the beggar in the street—were equally liable to attacks of these diseases; and that the intensity of the operating cause was the same in the palace as in the cottage.

* Report on the Sanitary Condition of the labouring Population of Scotland.

† Cholera Report by the Board of Health. 1848-9.

In the next place, certain circumstances, not previously considered to be exciting causes of disease, are set down as such at present. One of these is, the impurity of the atmosphere, produced by the congregation of a number of individuals in a confined space, or in the dense part of a town, or in small over-crowded and ill-ventilated apartments. Dr. Neil Arnott states:—"Our inquiries gave us the conviction that the immediate and chief cause of many of the diseases which impair the bodily and mental health of the people, and bring a considerable portion prematurely to the grave, is the poison of atmospheric impurity, arising from the accumulation in and around their dwellings of the decomposing remnants of the substances used for food and in their arts, and of *the impurities given out from their own bodies.*" * By the latter expression is meant the impurities of expired air; for the same writer adds, further on: "Effluvium from such filth as cesspools contain has, in past inquiries, been that most attended to, but there are many facts to show that the impurity of retained and corrupted breath, scarcely heeded in general, has been the chief element of the foul atmosphere which has led to numerous cholera outbreaks." And Mr. Grainger, referring to the prevalence of cholera in a public establishment, states,—that *no other cause* could be assigned for the outbreak than *overcrowding* in the dormitories. But there is another source of evil that has been dwelt upon very forcibly of late, and this is, the use of impure water. In fact, the greater prevalence of cholera in certain districts, as those near the banks of the Thames, has been ascribed entirely to this cause,—these districts deriving their supply of water almost exclusively from the river. This is so well known, and has attracted so much attention,

* Report of Health of Towns Commission, p. 50.

that it is unnecessary to adduce proof in support of the assertion.

It is thus evident that the advocates of the theory under discussion refer the production of disease to three different sources:—

1st. To the decomposition of vegetable and animal substances, no matter whence derived;

2d. To the congregation of human beings in houses or towns, and the vitiation of the atmosphere by respiration, or by the emanations from the surface of the body; and

3d. To the use of impure water.

We will, therefore, briefly consider the influence of the above causes in the production of endemic diseases. And, first, with respect to the decomposition of organic matter.*

That putrescent matter is injurious to man, at particular times and under particular circumstances, there can be no doubt. Thus, when animal substances, in a state of decomposition, are taken into the stomach, they sometimes give rise to derangement of this organ, or the bowels, producing sickness or diarrhœa, or both. If continued for any length of time, the general system becomes deranged, the blood undergoes a certain change, and a state approaching to putrescency supervenes. But it is only under particular circumstances, and with certain individuals, or when the putrid matter is in a state of

* The Medical Council called together by Sir B. Hall, the then President of the Board of Health, during the outbreak of cholera in 1854, and composed of the leading members of the profession—the heads of the Colleges of Physicians and Surgeons,—appear to have given in their adhesion to this doctrine. They remark in their Report:—"It seems certain that in the Chemistry of organic decomposition, there is contained a large share of the mystery we would solve."

concentration, that such an effect is produced. As is well known to all *bons vivants*, game in a half-putrid, or, as it is termed, high state, can be taken with impunity by every one; while no greater treat can be given to the lower class of Chinamen, who seldom taste animal food, than the putrid carcass of a dog, which they devour with no less impunity than delight. The inhabitants of the Arctic regions, also, live upon half-putrid fish and blubber for six months in the year, without any ill results. Mr. Pennant, speaking of the natives of Kamtschatka, says:—"Their ambrosial repast is the Hingal, or fish flung into a pit until it is quite rotten; when it is served up in a state of carrion, and with a stench that is insupportable to every one but a Kamtschatkan."* And yet, the writer adds, they are seldom attacked with any other disease than scurvy—a result due to the non-employment of vegetables. Few, or no conclusions, however, can be drawn from such facts, for the immunity, in these cases, may be ascribed to the antiseptic qualities of the gastric juice, which is probably the fact. Be this as it may, we know that when substances, in a state of great putridity, are injected into the veins, or placed in contact with the cellular tissue, so as to be absorbed into the system, they give rise to a variety of morbid symptoms; and, when the quantity is sufficiently great, to death itself, as the experiments of Magendie, Gaspard, and Orfila have clearly demonstrated. But that is not now the question. We have nothing to do with putrescent *matter* itself, for this only enters the system by accident, or with the food, while the morbid effects produced belong to another and a different subject—that of Toxicology. If ordinary diseases are produced by the decomposition of organic matter on the surface, it is

* Arctic Zoology.

apparent that they must be due, *not* to the matter itself, which cannot enter the system, but to the products of its decomposition; and which, being gaseous, are diffused in the surrounding air. These are not only different in their chemical and physical properties, but also in their effect on the health of man, as we shall presently find. Nothing, however, is said by the above writers as to the nature of the poison of which they speak, or to which of the products of putrefaction the morbid effects are to be referred; for, as we are now well acquainted with the products of the decomposition of organic matter, it would seem easy to point out the morbid agent. But on this point we are left entirely in the dark. "Of the composition of the poison," observes Dr. Southwood Smith, "of the laws which regulate its formation, and of its properties, when generated, we know nothing beyond its power to strike the human being with sickness or death. We know that, under certain circumstances, vegetable and animal substances will putrefy; we know that a poison, capable of producing fever, will result from this putrefactive process, and we know *nothing more.*" Having, therefore, no clue to guide us from those who have led us into the labyrinth, it only remains to ascertain if we cannot discover the path that leads to the Temple of Science on this particular occasion; for that "know-nothing" is a very unsatisfactory state to remain in on so important a question. I shall therefore endeavour to ascertain if either of the products of putrefaction, or the whole of them combined, can be productive of the effects under consideration.

Magendie instituted a series of experiments to illustrate this point; a detail of which will be interesting and important at the present moment. The following is the way in which the experiments were conducted:—"Having

arranged a cask in such a way that the bottom could hold the putrid substances, whilst the animals were placed on a grating, with a double bottom, exposed to the emanations which constantly escaped, it was shown that rabbits, guinea-pigs, and pigeons, which were left there about a month, did *not* experience any ill result. Dogs, on the contrary, submitted to the same experiment, began to lose flesh from the fourth day, and although they preserved their gaiety and their appetite, they died, apparently, from exhaustion at the end of ten, fifteen, or twenty days without offering *any of the symptoms* observed with the animals in whose veins *putrid matters had been injected.*" * It is somewhat difficult to account for the death of the latter animals, but it is probable that it was due rather to the deprivation of oxygen, than to the direct action of the putrid emanations. As the smaller animals require a less supply of oxygen, such an inference will account, not only for the death of the dogs, but also for the exemption of the former class. This conclusion is strengthened by the fact that birds, when exposed to the influence of noxious gases, perish much more rapidly than other animals, even with an infinitely less quantity of the poison. It thus appears, by the result of these experiments, that the inspiration of the products of putrefaction do not produce any particular morbid effect that can be compared to any of the ordinary and specific diseases. It was not necessary, however, to refer to these experiments in order to ascertain the effect of such agents on the animal frame : there is an abundance of facts which can be adduced in order to demonstrate the influence of these substances when inspired into the system by man.

There are, as is well known, certain trades—such as leather-dressers and bone manufacturers—in which exha-

* Journal de Physiologie expérimentale ; année 1832.

lations are constantly given off from animal matter, in a state of putridity: if, therefore, such emanations be injurious, we should expect to find that the workmen would be more subject to fever, &c., than any other class. But such is not the fact. Mr. Newman informs us that the leather-dressers at Stoke Croft, Bristol, are not only healthy, but more so than the rest of the labouring poor, although, during the last part of the process, the stench is intolerable.* In the tan yards at Bermondsey, there are about 700 workmen, who are remarkably healthy.† During the prevalence of yellow fever in the South of Spain in 1800, there were thirty-eight men and women and nine children employed in some tan vats near Xeres. Two of the men went into the town every day to market, at a time when from 180 to 250 were dying there daily; yet neither they nor any of the other workpeople had an attack. We are also told that the same exemption occurred during the visitation of 1804.‡ Brachet also states that he had visited certain tanneries placed near to *foci* of intermittent fever; that he has questioned the men, and invariably received from them the reply, "That the disease respected the establishment."§ Dr. Chisholme, again, cites the instance of a manufactory, near Bitton, Gloucestershire, for the produce of muriate of ammonia and sulphate of soda, and where the distillation of the medullary oil produces the most nauseating fetor; yet no fever is known to arise,

* Sanitary Inquiry, Scotland.

† I do not know whether this class was more exempt than others during the prevalence of the epidemic cholera, but we may be certain that if they had suffered to a greater extent, the fact would have been proclaimed on the housetop by those who have condemned these manufactories as so many pest-houses.

‡ Sir T. Fellowes on Yellow Fever.

§ Archives Générales de Médecine, t. 9, p. 380.

although the neighbourhood is thickly populated. The same exemption has been remarked at a manufactory between Bristol and Henham for the conversion of dead animals into a substance resembling spermaceti, and where the same putrid exhalations are given out.

Slaughter-houses, also, have been condemned as prejudicial to health, and promoters of disease; and yet butchers have always been singularly exempt from the prevalence of epidemic diseases, as was particularly remarked at the period of the Plague, as well as since the appearance of the epidemic cholera. They also appear to be equally exempt from endemic disease, or fever. Dr. Tweedie, in his work on Fever, remarks:—"Though almost every description of mechanic was, at some period or other, admitted last year into the Fever Hospital, I do not recollect a single instance of a *butcher* being sent to the establishment." If, again, we take that sure standard of health, the rate of mortality, we shall find that there are few classes that exhibit so favourable a result. With the exception of the merchant, shopkeeper, and domestic servant, who are in the first class, and whose average age is fifty-nine, the duration of life is greater with the butcher, poultryman, and fishmonger than any other class —being fifty-three years.*

But we have a very ancient record of the innocuousness of animal exhalations. After the frogs had covered the land of Egypt, when "they died out of (or, rather, in) the houses, and villages, and fields, and were collected into heaps, and the land stank," † no plague or fever followed their putrefaction: the disease appeared previously. Dr. Bancroft, also, states that in some parts of Cambridgeshire, a small freshwater fish, called stickleback, becomes

* Dr. Letheby's Report, 1858. † Exodus v. 13, 14.

so plentiful at times, that they form vast shoals in the rivers, and, being caught in nets or baskets, are strewed over the ground, in the proportion of twenty bushels per acre. "No marked effect, however, as far as I can discover, has ever been known to result from the putrefaction of fish, or other animal matters employed in this way." * A Mr. Ritchie, who had a manufactory for boiling down the blubber from whales, told the above author that the effluvia from the coppers, although very great, so far from being unhealthy, are, on the contrary reckoned wholesome; so much so, that it is very common for sick persons to go and hold their heads over the coppers for the relief of different ailments.

But there is a particular kind of animal matter, the decomposition of which has been considered more injurious still, and which, therefore, calls for an attentive examination: I allude to the decay of human bodies, and to the generation of gaseous matter by the accumulation of a large number of corpses in a small space. In fact, every disease that has occurred in the neighbourhood of churchyards has been ascribed of late years by this class of writers to the exhalations given out from the decaying bodies. Not only fever, but attacks of cholera, erratic as this disease sometimes is, have been referred to this single cause. The death of Mr. Key, the surgeon, was ascribed to the graveyard at the back of his house; and Mr. Grainger informs us that Bristol affords more than one example of an outbreak of cholera, in which a chief exciting cause was the existence of an over-crowded burial-ground, in the affected locality.† "I witnessed," says Dr. Sutherland, "several outbreaks of cholera in the

* Essay on Yellow Fever, p. 642.

† Report, General Board of Health, 1848-9.

vicinity of graveyards, which left no doubt on my mind as to the connexion between the disease itself and such local influences." *

With respect to the latter disease, I have, in my unpublished Report, shown that the accumulation of a large number of bodies in a small space failed to prolong the ordinary duration of the epidemic, or to cause its return, as might have been expected, if cholera could be produced by such a cause. On the other hand, the same circumstances would appear to have had no influence in the production of endemic disease. For instance, at Bridge Town, Barbadoes, 8,000 bodies were buried in the course of a few weeks, in a confined space of ground of about two acres, at one extremity of the town; and yet neither fever nor any other disease occurred afterwards to the inhabitants of the surrounding district. The same remarks will apply to nearly all the large towns in the West Indies, in consequence of the same practice having been pursued—that of burying the victims of cholera in one spot or field.

A similar immunity, under precisely the same circumstances, has been remarked during the prevalence of other epidemics, as the yellow fever and plague. M. Berthe, who, with other Commissioners, was sent to Spain by the French Government to investigate the causes of the yellow fever which prevailed there in 1800, informs us that, on visiting one of the burial-grounds near Seville, where 10,000 bodies had been interred some months previously, he found the ground cracked into wide and deep crevices, through which a fœtid odour was exhaled, the result of the decomposition which was going on among those heaps of bodies. "Yet no ill result ensued, not-

* Report of General Board of Health on Extramural Sepulture.

withstanding the pious and daily pilgrimage of thousands of the inhabitants to the place of sepulture of their friends and relatives." * Some fears having been expressed on the subject, not only as regarded the state of this cemetery, but that of the churches where bodies had also been interred, the French Commission, in answer to an inquiry of the Board of Health at Seville, rightly observed:—" If the yellow fever *could* be reproduced by the effluvia arising from putrefying bodies, it was evident that such a misfortune must already have taken place, through the imperfect manner in which the tombs and vaults pointed out by them had been closed—a defect that they had observed in the churches that were most frequented." With respect to the Plague, Deemerbroeck † long since remarked, that this disease was never reproduced from dead bodies, or from their accumulation in burial-grounds; and Mr. Howard, the philanthropist, confirmed the statement while referring to a visitation of the disease at Smyrna. No other conclusion, in fact, can be drawn by those acquainted with the history of the Plague during its different visitations in Europe. In consequence of the ravages of the disease, there were necessarily immense accumulations of bodies in all the large towns. In London, 100,000 were cut off in one visitation, while 50,000 bodies, according to Barnes, were placed in common pits, arranged in layers. Yet the duration of the disease was not prolonged by this circumstance; for the Plague, like cholera, appeared to be regulated by fixed laws: its rise and decline being gradual and uniform, while it only prevailed for regular and limited periods. More than this, it only returned at regular and

* Précis Historique de la Maladie qui a regnée dans l'Andalousie.

† Tractatus de Peste, lib. i., cap. 8.

long intervals, and then prevailed generally, attacking, not only the towns, but the villages and solitary houses, where such a cause could not be in operation.

That the emanations arising from the decomposition of human bodies do not and cannot produce either epidemic or endemic diseases, we may learn from what occurred at the Cemetery of the Innocents at Paris, where there was a larger collection of bodies, and which continued for a longer period than in any other locality, or under any other circumstances of which we have any record. This cemetery, situated in the centre of Paris, has been rendered memorable on several accounts, and, more particularly, by the operation that was carried out in 1785 of removing all the bodies, together with an immense quantity of earth, which had accumulated, so as to raise the ground eight or ten feet above the surrounding level. This undertaking, although rendered absolutely necessary at last, was considered to be not only a gigantic, but a dangerous one. "Since 1186," remarks Dr. Thœuet, who was appointed by Government to superintend the operation, "that this cemetery, already very ancient, had become enclosed with walls by Philip Augustus, it had not ceased to serve as the place of sepulture for the greater number of parishes in Paris."* Upwards of 90,000 bodies had been interred in the space of thirty years by one grave-digger; and it was calculated that more than 600,000 bodies had been buried there during the six previous centuries. In consequence of the confined space—not more than *two acres*—it had been the custom to bury the bodies of the poor in common pits, and they were placed so close to each other, as to be only separated by two planks of six lines each. These pits were twenty feet deep and twenty wide; each contained

* Mémoire lu à la Société Royale de Médecine, Paris.

from 1,000 to 1,500 bodies. When full, a layer of earth, a foot deep only, was laid over the last tier of coffins, and a new pit dug; but, as it took about three years to fill one of these pits, it was necessarily open the whole of that time. The gaseous products of decomposition, therefore, instead of being absorbed by the soil, as under ordinary circumstances, were diffused in the surrounding air, and the health of the inhabitants in the immediate neighbourhood must have been seriously affected, if it be possible to produce disease by such a cause. The ground, it should be remarked, remained undisturbed for a period varying from fifteen to thirty years, when a new pit would be dug *in the same spot.* Here, then, was another source of supposed danger. And yet it does not appear that the immediate residents of the cemetery, although placed in the midst of a populous district, suffered from either epidemic or endemic diseases more than the other inhabitants of Paris. Complaints were made in 1554 of the smell which arose from the burial-ground, and it was stated that the Plague lingered longer in this neighbourhood than elsewhere; but no deduction can be drawn from this fact, for it is a characteristic of all epidemics to attack particular localities at one visitation, and to leave them untouched at another. In the middle of the eighteenth century these complaints were renewed, and it was stated by the inhabitants that the noxious vapours disengaged from the *fossés* had penetrated into the cellars of the houses, affecting the inmates when they descended, and causing meat to become sooner putrid. No mention, however, is made of the inhabitants of the district being subject to attacks of disease more than others, which would doubtless have been done if such had been the case. Nor had this immense accumulation in the heart of a great city produced any ill effect on the

inhabitants of Paris in general, as we may learn, not only from the bills of mortality, which presented latterly a decreased rather than an increased ratio, but also from the fact that the Plague had ceased to prevail for a century previously to the closure of the cemetery.* "Such was the state of things," observes M. Thœuet, "when they dared to undertake the exhumation of the Cemetery 'des Innocens.' It was accomplished in the midst of the greatest calm, during the space of six months, and at different periods. A layer of eight or ten feet of earth, more or less infected from the remains of the bodies, and from the filth of the adjoining houses, was carried away. from the whole surface of the cemetery and of the church, in order to lower the ground to the level of the streets; more than eighty vaults were opened and searched; forty or fifty of the common pits were excavated to the depth of eight or ten feet—many even to the bottom; and more than from fifteen to twenty thousand bodies, at all periods of decay, were exhumed with their coffins, by day and by night. It was not only in the middle of winter that these works were executed; they were also carried on, in part, during the heat of summer." And what was the result? A visitation of plague, or fever, to the surrounding inhabitants; or death and accidents—the production of asphyxia, &c.—to the workmen, as has been gravely asserted by certain writers when reference is made to this memorable event? M. Thœuet will be the best able to answer the question. "These exhumations were commenced with the ordinary precautions, and they were continued and terminated with the employment of scarcely

* The plague years of the seventeenth century were 1603, 1625, 1636, and 1665; but, in the fourteenth, fifteenth, and sixteenth centuries, when the disease raged to a much greater extent, the intervals were shorter—ten years rarely passing without a visitation.

any, for no accident disturbed the public tranquillity." The cause of this immunity admits of a satisfactory explanation.

From the information furnished by the grave-diggers to M. Foderè, the celebrated chemist, who was anxious to collect some of the gases for examination, it is only at a particular period or moment that the emanations from the bodies are productive of any ill effect to those that inhale them. This is when the abdomen bursts, from the distension of the gases generated therein—a result that takes place at a period ranging from three days to three weeks, according to the state of the corpse, the temperature, and the weather. The effect, we are told, was hastened after a storm, according to the expression of the men, *le ventre bout a l'approche des orages.* "An extensive experience," observes M. Foderè, "and which is confirmed by a tradition long existing among them, has taught the grave-diggers that it is only at this period when the emanations arising from bodies in a state of decay are productive of any danger to them."* When in a concentrated state, and when an individual was close to the body or bodies from which it proceeded, the gaseous compound was sufficiently powerful to produce asphyxia; but when at a greater distance, only slight vertigo, faintness, and malaria. These symptoms were followed by trembling, weakness, and loss of appetite for some days after, but no symptoms of fever or bowel complaint were observed. No ill effects, however, were experienced when the individuals were at a certain distance from the body—a fact of some interest and importance, for it enables us to understand why the neighbourhood of cemeteries is not prejudicial to health. Under ordinary circumstances, the gaseous matter would be absorbed by the soil, and, if not decomposed, would,

* Mémoire lu à l'Académie des Sciences les 20 et 28 Mai, 1789.

at all events, be prevented from being diffused in the surrounding air. When, however, as in the case of the above cemetery, the gas escaped into the atmosphere, from the absence of a sufficient quantity of earth, we may infer that it becomes speedily innocuous from dilution in the aërial medium. In fact, if those placed only at a few feet distance from the grave were not affected, those who were one or two hundred feet distant, and at some elevation, could not experience any injurious result from such emanations. That such a cause is not injurious, or detrimental to life, we may learn from the fact that one grave-digger had followed his occupation for *thirty years*, and had assisted in burying 90,000 bodies, the greater number in pits filled with the emanations from other bodies, in all stages of putrescency.

That noxious elements, the result of long accumulation and retention of putrescent matter, are not given out from the soil of cemeteries, we may also learn from the fact that the workmen and others engaged in the removal of the earth as well as the bodies, felt no ill effect from the operation. This exemption will appear the more singular when we remember that, from the small quantity of earth there, the latter must have been little more than a mass of decomposing animal matter. More than this, "those," as M. Thœuet justly remarks, "that the epidemics had carried off had also been interred there, and exhalations the most dangerous were to be feared, if the principles of contagion, which survive the victims of disease, fix themselves also, after death, to the emanations which they give out." And yet no disease, either epidemic or endemic, occurred among the inhabitants of the neighbourhood, while the workmen escaped without so much as one having been carried to the Hôtel Dieu, labouring under an attack of plague, cholera, or fever.

Independently of the above, it can be shown that the gas usually extricated from the soil of cemeteries is not deleterious. It has been stated that a noxious matter is given out from bodies at a particular period only; while it has also been inferred that it is absorbed by the soil, under ordinary circumstances, or, if not, that it becomes speedily innocuous from the dilution in the surrounding air. We know nothing positive of the chemical properties of this gaseous matter, for it exists in so small a quantity that it has never been collected or analysed; but we may infer that it is composed of the ordinary and known products of putrefaction,—the conclusion at which Foderè arrived, for he states that it is a mixture of hydrogen and azote, holding phosphorus and sulphur in solution. The properties and action of these will be presently considered. There is, however, another gas, the nature of which we are better acquainted with, as it is not only generated and extricated in large quantities, but it collects in the soil and on the surface so as to be easily recognised; and the name it has received is *carbonic acid gas.* This is the dreadful agent which is made a sort of "Will o' the Wisp" of, to frighten weak-minded persons and astonish the credulous. It is stated by Mr. Chadwick that Dr. Reid detected the escape of *deleterious* miasma from graves; but, then, what was the nature of the miasm? The latter gentleman states:—"In some churchyards I have noticed the ground to be absolutely saturated with carbonic acid gas, so that whenever a deep grave was dug, it was filled, in some hours afterwards, with such an amount of carbonic acid, that the workmen could not descend without danger." * Dr. Lyon Playfair gives similar evidence, a conclusion confirmed by Dr. Reicke, who informs us that "in a cemetery in Paris,

* Report on Interment in Towns, p. 28.

near to the Rue de la Lingerie, which yearly received from 2,000 to 3,000 corpses, and in which 1,500 bodies had been placed in one pit the year previous, it was found that the cellars of the adjoining houses were no longer fit for use. Candles were extinguished, and those who descended into them were seized with alarming symptoms; but these effects ceased on the bodies being covered with half a foot of lime." This shows that the exhalation was merely carbonic acid. Now it will be evident, from the facts adduced hereafter, that whatever ill results this gaseous substance may produce in the extinguishing of lights, or even of life itself, it will never, can never be productive of fever, or any other disease.

With such facts as these before us, what, we may ask, becomes of the conclusions of the writers before quoted as to the injurious effect of the emanations from churchyards? They must be utterly valueless and erroneous. That disease will break out in such situations is an undoubted fact, while it may also prevail there at times to a greater extent than elsewhere; but then I have yet to learn that coincidence is cause. Were it so, we might, as Sir John Herschell has quaintly remarked, consider the night to be the cause of the day, or the day of the night, for these phenomena are connected inseparably together.* But we do not argue thus in the physical sciences, neither should we in medical inquiries. Before any deduction can be drawn from such a circumstance, it should be shown that a particular disease prevails only, or principally, in such situations, and in greater intensity: this, evidence, however, is entirely wanting.

That the products of the decomposition of animal bodies are innocuous, or, at least, that they are not productive of ordinary diseases, will also be rendered

* The Study of Natural Philosophy.

manifest by other facts. A student in medicine who remains four or five hours a day, and for several months in the year, in an atmosphere filled with putrid exhalations, and seated over a body in a state of decomposition, is not, in consequence, more disposed to disease than other individuals. He may lose his appetite, his florid colour and good looks, from the want of fresh air and exercise, but he will not be subject to attacks of epidemic or endemic diseases more than other individuals. Of this fact there is no doubt whatever. Dessault, Roux, Dupuytren, and Serres, the present Inspector of the dissecting rooms at Clamart, have all testified to the innocuousness of such emanations in the production of ordinary diseases. Andral and Lawrence have also pointed out the good health enjoyed by the men employed in these establishments, although some of them have actually lived and slept in such an atmosphere for years. Dessault has made, in addition, a singular remark. He states that those students who were only attending the lectures, or whose duties confined them to the hospital, were always attacked with the prevailing complaint, no matter what it might be; those, on the contrary, who were engaged all day in dissecting, remained, as generally, exempt. This is not an isolated example, for the same immunity has been remarked with those who are exposed to the emanations arising from the carcases of animals. Of this a most striking example has been afforded by Parent du Châtelet in his work on Hygiène.

As is well known to most persons conversant with Paris, there is one of the most extensive knacker's-yards at Montfaucon to be found anywhere, or in any country,—thousands of horses, dogs, and cats, being taken there every year to be slaughtered; while the flesh and offal, after the animals have been skinned, are allowed to remain on the

ground and putrify for the purpose of manure. "Every-one can imagine," observes Parent du Châtelet, "the fœtid odour produced by heaps of flesh left to putrify for months in the open air, and in the heat of the sun; to which must be added the gases given out from mountains of skeletons not properly cleansed from the soft parts; and the emanations arising from a soil saturated, from year to year, with blood and animal liquids, &c. Multiply at pleasure the degree of infection, similar to that which each of us (the Members of the Commission) experienced, on passing near the carcases of the putrid animals which we encountered, and a feeble idea will then only be formed of the horrid odour of this *cloaque*, the most infectious that it is possible to imagine."* After the above recital, and other particulars, which it is unnecessary to enter into now, the Author passes to a consideration of the effects of these emanations on the health of the workmen, and then adds:—"If you interrogate the numerous workmen (knackers and others) who belong to the establishment, they will answer that they are *never* ill, and that the effluvia which they inhale, far from injuring them, contribute to keep them in good health." Again: "if you examine them, you will see that they all have the appearance of the most perfect health, and that, under this report, they resemble the butchers. We are not the only persons to draw such a picture, as will be shown by a reference to the Report made in 1810 by MM. Dejeux, Parmentier, and Pariset, respecting this establishment, which was then at the Gare. These writers speak of the surprise which they experienced at the robust health of the wife and five sons of Friand, who all the year worked and slept in a place that was

* Les Chantiers d'equarressage de la Ville de Paris.

actually unapproachable to the Members of the Commission."

This, however, is not all. The same author observes: "It will be said, perhaps, that the duration of life is less with these men than with others; but it is," he adds, "*quite the contrary.* You will see many knackers of sixty and seventy years of age, and who, perhaps, are the most robust and active of all those who pursue their trade in this establishment. We have inquired respecting their parents, and have ascertained that they all died at an advanced age; of the last three that died, one was sixty, another seventy, and a third (of the name of Laiseau), eighty-four years of age."

M. Parent du Châtelet next enters into the question as to whether the workmen had become habituated to these emanations by degrees, and that their exemption from disease is to be ascribed to this single circumstance, as is frequently concluded by certain writers. Such an inference is not only negatived by the preceding facts—the exemption of the workmen from *ordinary* and epidemic diseases, and their greater longevity—but, also, by certain others. Messrs. Damoiseau and Huzard, the Directors (the latter, be it observed, having visited the premises daily for sixty years), stated, that sometimes it was necessary to employ extra labourers, when the ordinary ones did not suffice; but they had never remarked that such individuals were more susceptible to disease than the others. There are, also, quarries in the immediate neighbourhood of the establishment, and the workmen, when questioned, one and all expressed their disgust at the exhalations to which they were subject; but not one spoke of any ill effect arising to their health, although their occupations keep them there the best part of the

year and during the heats of summer, when the infection is at its highest degree. Again; children, as is well known, are peculiarly susceptible to the influence of all morbid agents, as witness the great mortality that occurs among them. Now, many of the workmen live at Montfaucon with their wives, who are also employed in the establishment, and the Commission speak of the robust health of the children born there, and, more particularly, of an infant, whose *cradle*, during the hours of labour, was *the carcase of a horse!* It is only necessary to add one other remark to the above catalogue of negative facts; and this is, that the epidemic cholera spared this establishment in 1832,—a singular and almost solitary exception during that severe outbreak.

We may therefore conclude, as the deduction from the foregoing facts, that the products of animal decomposition, when diffused in the surrounding air, are not the exciting causes of disease, in the ordinary signification of the term; and that they do not even predispose individuals, subject to their influence, to attacks of either epidemics or endemics. This is not my conclusion alone, but that of many other writers, as must be evident from the quotations already given. Dr. Chisholm, one of the professors of Edinburgh, has drawn the following conclusions on the subject:—"1st, That the theory of ingenious men, founded on experiments or speculations, to prove the pestilential influence of putrid animal effluvia, receives no support from practical knowledge, or the known economy of nature. 2d. That in no known and well-ascertained instance are putrid animal exhalations productive of pestilential fevers. And 3dly, That in every instance, which seems hitherto to have been investigated, wherein animal effluvia have been supposed to be the cause of epidemic malignant fever, other agents

of a less dubious character and well-ascertained nature exist." *

We may now turn to the effect of putrid vegetable substances on the human frame. Passing by the matter itself, as foreign to our present inquiry, I may observe, that there are no direct facts to prove the noxious qualities of *the products* of vegetable decomposition. Although disease prevails to a considerable extent, and principally in situations where the decomposition of vegetable matter is going on to the greatest extent, viz., in the alluvial tracts of temperate and intertropical climates, it does not follow that the morbid effects, thus witnessed, are due to the presence of this matter; for, as I had occasion to remark before, coincidence is not cause. As to the fact of the greater prevalence of disease in such situations, it can be explained without reference to the decomposition of organic matter, as will be more particularly pointed out hereafter. It is, therefore, necessary to inquire, if there be any facts which demonstrate the innocuousness of the products of vegetable decomposition. There are a great many.

I may observe, in the first place, that if this matter were productive of material injury to men, the rate of mortality ought to be higher in the country than in towns, for it is precisely in the former situation that the decomposition of vegetable substances is going on to the greatest extent, and almost continuously. The contrary, however, is the fact, at least in temperate regions; for agricultural labourers are, in general, more healthy than the inhabitants of the city. In intertropical regions, it is true, disease is more rife in the country than in the town; but, then, this occurs in situations where the amount of vegetable matter is generally least, viz., in

* "Edinburgh Medical and Surgical Journal," vol. vi., p. 90.

marshes; while in those where it most abounds—the immense forests in the interior of the country, diseases are comparatively rare. Had it been otherwise, the world would have been depopulated ere this.

In the next place, persons exposed to the emanations arising from decomposing vegetable matter, when no other causes are in operation, such as exhalations from the soil, are not found, under these circumstances, to contract disease. For instance, the drainings of the sugar, in a West India ship, mixing with the bilge-water in the hold, create a stench that is absolutely suffocating to those unaccustomed to it; yet fevers, as Dr. Ferguson has justly remarked, are never known to be generated from such a cause.* It is, also, almost universally asserted, that the emanations given out during the maceration of hemp are productive of intermittent fevers. It has, however, been clearly demonstrated, by Parent du Châtelet, that when the maceration takes place in houses, or rooms, the emanations are then innocuous—not only healthy persons, but even those that have previously suffered from ague, and who, in general, are peculiarly susceptible to morbid influences, having slept in such rooms with impunity.† Here, again, is another example of a coincidence mistaken for a cause; the steeping of hemp taking place, in general, on the banks of rivers and lakes—situations in which intermittents exist, to a greater or less extent, in all climates. This fact will be more particularly pointed out hereafter.

So far from being injurious, the products of vegetable decomposition may prove beneficial; a fact that has been known for ages, the older physicians having been

* "Trans. Royal Society of Edinburgh," vol. ix., p. 273.

† Le Rouissage du Chanière, consideré sous le Rapport de l'Enggiène Publique. Mémoire 25.

accustomed to recommend certain patients to inhale the vapour of fresh turned earth. True, the process that is going on, under such circumstances, is, to a great extent, that of decay; the products of which are different to those of putrefaction; still, the latter process must exist, more or less, in all such situations, from the falling of leaves, the death of plants, &c., independently of the manuring which is applied to cultivate lands. How utterly ridiculous, then, must it be to talk of the vegetable matter, which exists in towns, being detrimental to health: particularly when we are told that an accumulation of *soaking straw and cabbage-leaves* in some miserable cellar is productive of the same mischief as the garbage of a slaughter-house, or an overflowing cesspool.* It is evident, from the preceding facts, that the products of vegetable decomposition, like that of animal putrefaction, are not the real or efficient causes of disease.

Independently of the above indirect evidence, it will be easy to show, by direct proof, that the products of putrefaction, whether animal or vegetable, do not and cannot cause either fever, cholera, or any other general disease. This proof can be obtained by an inquiry into the properties of the different gaseous substances evolved during the process of putrefaction, and their effects when inspired by man. These gases are carbonic acid, nitrogen or azote, sulphuretted hydrogen, carburetted hydrogen, phosphoretted hydrogen, and ammonia.

With respect to the first, although it has been accused of a great many sins, like old women in the dark ages, it is as innocent of them as were those presumed witches of the charges brought against them. So far from being a poison, as it is so generally termed, it is a most valuable

* Mr. Simon: Report for the City of London. 1849.

remedial agent, as I have had occasion to demonstrate on several occasions before. True, this gas cannot be inspired in any quantity, without producing injurious results, and even death itself, when the proportion is great. But what does that prove? Not that the gas is deleterious, but merely that it cannot supply the place of oxygen, like all other gaseous compounds, with which we are yet acquainted. Even nitrogen, when the usual proportions of atmospheric air are altered by the addition of a larger quantity of this gas, or, by the abstraction of a certain quantity of oxygen, will produce asphyxia and death. But we do not, in this case, ascribe the result to the noxious qualities of the gas, because it so happens that it is, in combination with oxygen, taken into the lungs, although not absorbed into the blood, at every inspiration. Not only nitrogen, but oxygen itself when in excess, produces injurious effects.* If, in fact, we are to conclude that a gaseous substance is poisonous, merely because an individual placed in that medium becomes asphyxiated and dies, we must also infer that water is a poison, for the same results are produced when an animal is plunged into this fluid, and kept there for a certain time. Before we can determine the noxious qualities of any substance, we must have other proof than that derived from its inspiration into the lungs; we must also ascertain that it produces deleterious effects when introduced into the stomach, the veins, and other parts of the system. But the evidence, in this case, proves the contrary; for

* Magendie, speaking of the properties of atmospheric air, remarks, "All the other gases cause the death of animals, more or less quickly; even oxygen itself, when it is pure, becomes mortal, and its mixture even with azote, in the proportions different to that of air, ends sooner or later in producing the death of the animals that respire it."—*Physiologie*, p. 298.

not only can carbonic acid be taken into the stomach in the largest possible quantity, with impunity, but it may also, as the experiments of Mysten have clearly demonstrated, be injected into the veins, without producing any injury, excepting that which arises from its bulk. More than this, it will hereafter be shown, that, when present in the atmosphere in certain proportions, it is, so far from being injurious, actually beneficial to health. We are therefore certain, that carbonic acid is not, and cannot be an exciting, or predisposing cause of disease; and we may draw the same conclusion with respect to nitrogen, for this gas can have no deleterious influence on the human economy.

As regards sulphuretted hydrogen, it acts, no doubt, as a direct poison, both with man and animals, and more particularly with the lower class of animals, as these die when only a minute quantity of the gas is present in the air; while similar effects are produced, when it is injected into the veins, cellular tissue, rectum, &c., as also when taken into the stomach. Its action, however, is less powerful, and less manifest with man, for not only can it be taken into the stomach in considerable quantities with impunity, but it can also be inspired without injury, when the proportion present in the air is small. As is well known, there are a great many mineral springs, which owe their property to the presence of this gas,—as the sulphurous waters of Aix-la-Chapelle, Aix les Bains, Harrogate, &c.,—and yet these waters are drank in large quantities, not only without detriment, but with benefit to the health, in a variety of complaints. More than this, the air of these places is impregnated, to a greater or less extent, with the same gaseous substances; but no one ever heard of any of the numerous visitors that frequent these springs, being attacked with fever, cholera, or other

disease. On the contrary, in many of these places, but not all,—for some sulphurous springs, as in Italy, are situated in malarious districts,—epidemic and endemic diseases are *unknown*. We are certain, therefore, that this gaseous compound cannot be productive of disease, in the ordinary signification of the term. *

The same conclusion may be drawn with respect to carburetted hydrogen, as this gas is not deleterious, *per se*, when inspired: it merely acts by preventing the introduction of oxygen into the system, the same as carbonic acid, nitrogen, and hydrogen. This is acknowledged by Orfila, who is disposed to regard certain gases as deleterious, which are not considered as such by other writers. † That it is not productive of disease, was inferred long since by Foderè; for he remarks that this gas can be inspired, in the laboratory, without producing any of the effects observed by the introduction of malaria into the system. ‡ It is this gas, also, which exists in such abundance in coal mines; but, however dangerous it may be, on account of its explosive qualities, it is not detrimental in other respects; for miners, who live in an atmosphere of carburetted hydrogen, are not more subject

* M. Gaspard has shown, by direct experiment, that neither carbonic acid, nor sulphuretted hydrogen, have any influence in the production of the morbid effects witnessed after the injection of putrid matters into the veins of animals. (Orfila, Toxicologie, vol. ii., p. 824.) This confirms the remarks previously made, that the action of the products of putrefaction is different to that of the putrid matter itself.

† This, at least, is the case with the gas produced during the process of putrefaction, for there are two gaseous compounds of hydrogen with carbon, the proto-carburetted hydrogen (Hydrogène proto-carbonè,) $C^2 H^4$: and the bi-carburetted hydrogen (hydrogène bicarbonè,) $C^4 H^4$, or, Olefiant gas; the first being innocuous, and the latter deleterious.

‡ Leçons sur les Epidemies et l' Hygiène.

to fever, or other diseases, than those who live on the surface. We may therefore pass on to the next substance, phosphoretted hydrogen.

This gas, although a deleterious one to man and animals, cannot be a cause of ordinary diseases, either epidemic or endemic, for several reasons. In the first place, one form of this gas undergoes spontaneous combustion at the ordinary temperature of the atmosphere; if, therefore, it be inspired at all, it will enter the system in the form of phosphoric, or phosphorous acid. Now, whatever ill results may arise from these combinations of phosphorus, no one, I presume, will think of attributing fever, or cholera, to their agency. In the next place, the other form of phosphoretted hydrogen, not spontaneously inflammable, although its action on the economy has not been clearly defined, is supposed by Orfila to produce the same effect as the solid phosphorus: if so, it will certainly not cause fever, for this substance has been given, with much success, in certain low fevers. Besides, both forms of this gas, although produced from certain vegetables in minute quantity, are more particularly the products of animal decomposition; they must therefore exist in too small a quantity, and over too limited a space, to exercise any influence in the production of such general effects as those we are now considering.

And, lastly, as respects ammonia, although an irritant poison, its effects, when taken into the system in large doses, are *sui generis*, and different to those produced by any ordinary disease. Were it not so, certain individuals, as nervous ladies for instance, who inspire the gas and take the solution into the stomach at one and the same time, would seldom be without an attack either of cholera, or fever—independently of the fact that ammonia is administered, as a remedy, in both these complaints. In

addition to this, as it is not an invariable product of decomposition, its influence must be too limited to produce any of those diseases that are more or less general, and which are observed at all times, and in all situations.

It may, however, be argued, that the marked effects under consideration are due, not to one particular product, but to the joint operation of two or more of these gases. In reply to such an hypothesis, it is sufficient to remark that, as the nature of the organic matter varies greatly in different localities, the products of its decomposition will also vary at the same time—one gas being present in one case, and absent in the other; while the proportion of those present will also differ under different circumstances. No compound, therefore, could be formed, possessing invariably the same composition, or the same elements; as such, the effects would vary in different localities, if not in each separate locality, and could never assimilate to those observed with epidemic and endemic diseases, which present the same pathognomonic characters in all situations and at all times. If these diseases be due to any of the products of decomposition, it must be either to sulphuretted hydrogen or carburetted hydrogen, for these are the only invariable products of this process to which such effects can be ascribed. If, however, the preceding arguments have any value, we must infer that neither of the above two classes of disease can be produced by these gaseous substances; for, while the one is innocuous, the morbid effects produced by the other are different to those observed in ordinary diseases. In addition to this, sulphuretted hydrogen has been administered as a remedy, and with success, in the very diseases said to be produced by the products of decomposition—viz., cholera and fever.

We must, therefore, conclude that general and specific diseases are not due to the decomposition of organic matter, either animal or vegetable.

There is, however, one particular substance, the decomposition of which produces different products to those already detailed, and which, therefore, requires a separate consideration: I allude to that matter which forms the excretion of man, and to the accumulation of which in large towns so many evils have been ascribed. Not only are the gases given off from cesspools and sewers supposed to be one of the chief causes of disease, but it is to the removal of this matter by an improved system of drainage before it has undergone decomposition that visitations of epidemic and other diseases are to be prevented in future. But I will let these writers speak for themselves.

Referring to the existence of cesspools, Mr. Simon says:—"Now, here is a remarkable cause of death;" and he adds, while speaking of the gases which they exhale, "they form a climate the most congenial for the multiplication of epidemic diseases."* Dr. Greenhow, one of the Inspectors to the Board of Health in 1854, states that, in addition to the other known causes productive of cholera, "the effluvia arising from collections of night-soil were by far the most influential." So much for epidemic diseases; now for endemic. "Next in order to overcrowding," observes Mr. Grainger, "as to the extent to which it prevails, and the evil results produced, is, according to my experience, what may be called 'the privy atmosphere.' Persons habitually exposed to such an atmosphere are thereby predisposed, in an especial degree, to fever and other sickness." . . . . "This is the

* Report on the Sanitary Condition of the City of London.

most common cause of the diarrhœa so generally prevalent among the poor in crowded cities." *

Having already discussed the influence of this cause in the production of epidemics in my two Reports, I shall content myself now with giving an extract from one of them:—"As regards the exhalations from drains and cesspools, if these are so injurious during the prevalence of the epidemic cholera, to what are we to attribute the exemption of the scavengers in London and the nightmen in Paris—the latter forming, with the exception of the charcoal porters, almost the only class that escaped the ravages of the disease in 1832?" † Leaving the above theorists to answer the question, I have only now to observe that the influence of this cause in the production of endemics is still less doubtful, and its innocuousness more easily demonstrated.

At Florence, in consequence of the poverty of the soil in the surrounding districts, the night-soil becomes a valuable manure, and it is, therefore, carefully preserved in cesspools, or reservoirs, *beneath the houses*. But, as the water-closets are not provided with traps, and as these conveniences are to be found on all the floors, the effluvium escapes, not only into the houses, but into nearly all the rooms—even the bed-rooms. In fact, I was obliged to change my apartment while residing there from this very cause.‡ But however disagreeable the effluvia were

* Report, General Board of Health, 1848-9.

† Statistical Report of the Epidemic Cholera in Jamaica.

‡ The late Dr. James Johnson, speaking of this town, says:—"The city of Florence, then, like too many of its neighbours, is a city of filth, where *not a single wave of air* is unimpregnated with the most disgusting, if not pestiferous, effluvia that imagination can conceive." And he adds:—"Why is this infernal box of Pandora, compared with which assafœtida is incense, gradually collected in the cellar, and annually disgorged by carts, instead of being daily carried subter-

to the olfactory organs, and although experiencing certain anomalous symptoms, referrible to the head, I had no attack of fever; while I was told that strangers never suffer from this disease in Florence. And yet neither they nor I could probably have traversed the Campagna of Rome in the hot season without experiencing an attack after; * although such emanations do not exist there, the night-soil of Rome, like that of London, being discharged into the river, instead of being applied to agricultural purposes. But, what is still more remarkable, Florence is entirely free from the endemic of Italy—intermittent fever; while it is not only the healthiest city in Italy, but as much so, perhaps, as any other in Europe. It has also been very lightly visited by epidemic cholera. The chief complaints in this town are those referrible to atmospherical vicissitudes, dependent on its position, being somewhat elevated, and surrounded by mountains: so that, while suffering an unusual amount of heat in the summer, it is equally cold in the winter.

If, however, we turn to Rome where the night-soil is conveyed into sewers, and where, in consequence of the city being on a higher level than the river, the drainage is so good that the emanations complained of at Florence do not exist, or at least only to a very trifling extent, we shall find a state the very reverse of this—Rome being, as is well known, the very hot-bed of fever, at least of intermittent fever, and in its worst and severest form.

raneanly into the Arno?" The answer is, that, although sewers exist in every street, the Tuscan Government is too wise to allow such valuable matter to be cast into the sea; although it would be still wiser not to allow the emanations from these cesspools to enter the houses, which could be easily effected.

* This was what actually occurred to myself; for, having left Florence for Rome in the middle of August, I had an attack of fever the day after my arrival in the latter city.

Independently of the above, the supply of water in Rome is so abundant that the accumulation of matter in the drains must be absolutely impossible. There is, perhaps, no city in the world so plentifully supplied with water as Rome: it is, in fact, a city of fountains, for they are to be met with in every street, while they play continuously day and night.*

There is another phenomenon which is remarked in all malarious districts, and in intertropical climates, which is of some importance in the elucidation of the present question. This is, that the danger of contracting fever lies, *not* in the city, where accumulations of this kind of matter exist to the greatest extent, but in the open plain, and in the uninhabited district. We shall of course be told by these theorists that there are, in such situations, the products of putrefaction, arising from collections of other

* Of all the monuments in Rome the ancient sewer, or *Cloaca Maxima*, is, perhaps, the most remarkable. It was built by Tarquin 150 years after the foundation of Rome, in order to drain the low and marshy land between the Capitol and the Palatine-hill, and which afterwards became the site of the Roman Forum. Although twenty-four centuries have elapsed since its construction, it is as solid and nearly as perfect now as the day of its completion,—notwithstanding the earthquakes and inundations from which Rome suffered so much at former periods. It has been formed of large blocks of tufa, or volcanic rock, some of them five feet long and three feet in thickness; while the length of the sewer, or at least the part which remains perfect, is about 800 feet. The diameter of the sewer, through which, Strabo observes, a waggon of hay might be driven, is thirteen feet at the entrance, but it becomes gradually contracted to ten and a-half feet, although the outlet is, or rather was, twelve feet. From an alteration in the bed of the river, there is now only a space of about four feet between the keystone and the usual level of the water. As a sewer, it is almost useless at present, that part of Rome being nearly uninhabited; but it is a lasting memorial of the skill of the ancient Romans.

kinds of matter; and that the effects in question are due to these agents. This, however, is no answer to the above opposing facts, for, as will be presently shown, the products of this matter are not the same as the ordinary products of putrefaction. If, therefore, fever and cholera arise where this matter does not exist, all conclusions respecting its noxious influence fall at once to the ground. This, however, is not all. It would appear that such emanations have, at particular times, and under particular circumstances, a preservative effect.

The exemption of the nightmen at Paris has been already mentioned: but this instance is not a solitary one. Mr. Rose, Night-soil Contractor, informs us that of 118 men employed by him for the purpose of emptying ash-pits by day, and cesspools at night, only four were attacked by cholera; and their illness was attributed to other causes than their employment. He also adds:— "It is worthy of remark, that the occupation of night-soil men is so healthy, that about fifty who go out to brickmaking or harvest work in summer, are so much reduced in health that it takes some months on their return to recover their usual looks."* Instead, therefore, of considering the products of the decomposition of this matter prejudicial to health, we might ask, as one French writer has already done, if there be not something *antidotal* to the production of cholera in such emanations! Instead of attempting to answer this question, I shall content myself with a short summary of the chemical and other properties of the gases given out from cesspools; and then leave other individuals to form their own opinions on the subject.

It is too commonly supposed that the strong and disagreeable smell arising from cesspools is due to the

* Medical Times, August 10, 1850.

presence of sulphuretted hydrogen, but Thénard has shown that the gas more generally extricated is the hydro-sulphuret of ammonia. The former gas is also present to a greater or less extent, and more particularly in recent collections; but it is the latter which is principally met with when the matter has accumulated for a longer period. At other times the gaseous matter, which is given off, is a compound, according to Orfila, of ninety-four parts of nitrogen, two parts of oxygen, and four of carbonic acid; but when ammonia is present, the latter gas unites with it to form the sesqui-carbonate of ammonia. There are thus three states in which these receptacles will be found; while the effects that are produced, by the exhalations given off, must necessarily vary in each.

In the first, we shall have sulphuretted hydrogen as the chief agent, combined with a greater or less amount of atmospheric air, as well as a portion of the other gases named. As, however, the properties of this gas have been already considered, it is unnecessary to dwell upon its action in this place. I would merely add, that one practitioner (Mr. Atkinson) administered this very agent as a remedy in cholera; and, as he states, with more success than with the ordinary remedies. Sulphur, also, has been administered with a like good result, and particularly in the first stages of the disease, although a considerable part of this substance is converted into sulphuretted hydrogen in its passage through the body. And yet Mr. Grainger tells us, that the presence of this gas in the air is the cause of ordinary diarrhœa *among the poor:* as if this class of persons were not subject to any other cause productive of derangement of the bowels —such as improper diet and poor living—and as if the rich never laboured under the same complaint from the opposite cause—over-eating and excess in drinking.

Under other circumstances, instead of the preceding, the hydro-sulphuret of ammonia will be the principal substance extricated. This gas, which is not a product of ordinary putrefaction, is (like the former) deleterious, but it produces a more powerful effect on the human frame. If, however, we turn to the medical records, and study the symptoms produced with individuals who have become asphyxiated by the inhalation of this gas after descending into cesspools, and who have recovered afterwards; we shall find that no symptoms similar to those of cholera or fever are produced. The principal effect would appear to be on the nervous system as indicated by the muscular contractions and convulsions that supervene. When, however, these have disappeared, the recovery of the patient is usually very rapid, so much so that individuals who were in a state of asphyxia for some hours, have sometimes left the Hôtel-Dieu at Paris *the next day.** The only symptoms experienced afterwards are those of great prostration. Had it been possible to produce fever, cholera, or any other ordinary disease by such a cause, some symptoms would assuredly have manifested themselves in these cases; particularly as such patients had imbibed the largest possible quantity of poison short of producing death itself. We may therefore conclude, that this gaseous compound, like sulphuretted hydrogen, is neither an exciting nor a predisposing cause of ordinary diseases.

With respect to the gaseous mixture, which is found in the last condition described, as it contains no noxious substance, it can only act injuriously when in a state of concentration, by preventing the ingress of oxygen into the lungs: it cannot, therefore, exert any influence in the production of the effects now under consideration.

* Traité de Toxicologie, p. 212.

There is thus direct, as well as indirect evidence to prove that the emanations from cesspools do not and cannot act as exciting causes of either epidemic or endemic diseases. We may therefore pass on to a consideration of the next supposed exciting cause of disease, viz., the vitiation of the atmosphere from over crowding, or the congregation of a number of individuals in a small space.

As is well known, man cannot exist without a due and proper quantity of oxygen: when deprived of the usual supply, the circulation languishes, while, if abstracted altogether, it is suddenly arrested. Hence, in large cities like London, certain effects, termed *etiolation*, are produced—the symptoms of which are, paleness from the non-oxygenation of the blood; deficiency of muscular energy, debility, &c., from the absence of the natural stimulus to the system. In other instances, when a number of individuals have been confined in a small space, as in the black hole of Calcutta, they have become asphyxiated and have died, the same as though they had been plunged into a body of water,—excepting that the fatal result has been less rapid. But these results have nothing to do with the subject of the present inquiry. What we want to know is, not whether certain morbid effects are produced by the congregation of a large body of individuals in a confined space; but, whether such a circumstance is a predisposing, or exciting cause of disease.

Dr. Arnott informs us, that "effluvium from such filth as cesspools contain has, in past inquiries, been that most attended to, but there are many facts to show that the impurity of retained and corrupted breath, scarcely heeded in general, has been the *chief* element of the foul atmo-

sphere which has led to numerous cholera outbreaks." Mr. Grainger * also states, as the general results of his observation of the epidemic in the metropolis, that "the force of the disease was in the ratio of the overcrowding, all other circumstances being the same." And again farther on: "In the large majority of instances in which cholera has broken out with unusual violence, it has, on a careful investigation, appeared that, whatever might be the case in regard to other noxious conditions, which might or might not be present, overcrowding was never absent. As far as my own personal experience extends, I have found no exception to this statement." †

Had my Report been published, a few words would have sufficed on the present occasion, as regards this particular disease, for I have demonstrated, by statistical facts, that density of population is not a predisposing or exciting cause of the epidemic cholera. From a Table inserted in that Report, it appears that the ratio of mortality, in the West Indies, was in an inverse ratio with that of population, and varied from 17 per cent. in the large towns, to 30 per cent. in the smaller ones, and to 40, 50, 60, nay 70 per cent. in the villages and settlements—and that, too, under circumstances in which the inhabitants in the latter localities had the same advantages as regards medical aid, &c., as those in the former. Such a result was not new, for the same had been observed previously in Asia and in Europe. Where, in fact, did the epidemic commit its greatest ravages, and prevail in its greatest intensity? In Arabia, among a scattered population, living principally in tents, and in the open air. We are also informed, by Moreau de Jannes, that the greatest number of cases and deaths, in proportion to the

* Loc. cit. p. 169. † Cholera Report, 1848-9, p. 86.

population, occurred among the scattered inhabitants of the mountainous districts of the Caucasus—16,000 persons, or two thirds of the population, being attacked, of which number 10,000 died. * But the same results, although not to the same extent, were observed in London, under the very nose of those who have drawn the preceding conclusions—writers who, instead of searching for facts, contented themselves with the enunciation of preconceived opinions, and unfounded assumptions. This will be evident by a reference to the following Tables, extracted from the Registrar General's Report, for 1849:—

TABLE 1.—Tabular view of the area, density of population, and mortality from cholera, and all diseases, in three groups of districts, in 1849.

	Localities.	Population.	Persons to an Acre.	Ratio of Deaths per cent.	
				From Cholera.	From all causes.
1	47 Districts, including the principal sea-port Towns . .	2,153,319	9	·85	2·53
2	41 Districts, including the principal inland Towns . .	2,243,183	13	·38	2·48
3	London	2,361,640	243	·62	2·57

* Rapport au Conseil Superieur de Santè, sur le Choléra Morbus. This author wrote his work to prove that the epidemic cholera was propagated by contagion; but he had the candour to acknowledge that the invasion of Europe by this route, instead of by Alexandria and the Mediterranean, where the disease had appeared seven years previously, was irreconcilable with this doctrine.

TABLE 2.—Tabular view of the density of population, with the mortality from cholera and other diseases, in certain districts of London, in 1849.

	Districts.	Number of persons to an acre.	Deaths to 10,000 inhabitants.	
			From Cholera.	From all causes.
1	East London	282	45	252
2	St. James, Westminster .	222	16	212
3	Clerkenwell	202	19	242
4	St. George, Southwark .	181	164	267
5	St. Saviour, ditto . .	141	133	292
6	St. Olave, ditto . . .	114	181	281
7	Bermondsey	66	161	264
8	Lambeth	34	120	233
9	Rotherhithe	19	205	277
10	Wandsworth	4	100	198

If we examine Table I., it will be apparent that the mortality from the epidemic cholera, in England, was greatest precisely in those districts where the density of population was the least. If, again, we turn to the next Table (II.), we shall find that the mortality from cholera, in London, was the greatest in that district, where, with one exception, the density of population was the least. On the other hand, the mortality was least in that district where, with one exception, the density was the greatest. If, again, we take that district where the density of population is least (No. 10), and then compare it with the district where the density is greatest (No. 1), what shall we find? that the mortality, in the latter, was less than

half that in the former. We shall, of course, be told, that, although the general density of the population was less, there was overcrowding in the houses, or in the rooms. Those, however, who know anything of Wandsworth will be able to negative such a conclusion; for the poor are as well, if not better, lodged in that district than any other in London, or in the neighbourhood. Besides, if overcrowding in houses and apartments exerted so noxious an influence, how was it, I would ask these theorists, that the large establishments in London, such as the hospitals, prisons, and workhouses were less ravaged than private houses? At St. Bartholomew's Hospital, containing 500 patients, there was not a single case in 1849, although the disease prevailed to a considerable extent in the neighbourhood, and although a great many cases were admitted from without. It would almost seem that the Inspectors of the Board of Health, when they visited a district, had put a bandage on their eyes and cotton in their ears, in order not to listen to the voice of the charmer—the goddess whose words are generally those of truth and soberness, and who deals not in abstract opinions and theories, but in facts. The truth is, that when men take up a particular hobby, it renders them blind to all other objects and deaf to the arguments of all other persons. The medical Council that sat in 1854, better informed, or less led away by abstract opinions and theories, drew a different conclusion. They observe:—"It does not appear that the great differences in the density of the habitations of the people exercised any decisive influence on the intensity of its operation"—the cholera leaven. They state that, "The mean mortality by cholera and diarrhœa in the nine most open districts (in London)

was 85 in 10,000, and in the nine densest districts it was 58 in 10,000." * . . . . . "In Lewisham, where the population is the least dense (two persons to an acre), the mortality was twenty-two per myriad from cholera, and twenty from diarrhœa (total, forty-two); in East London, where the density of population is the greatest (290 to an acre) the mortality was twenty-three per myriad from cholera, and twenty-six from diarrhœa" † (total, forty-nine).

But the operation of this cause would appear, in the opinion of these theorists, of as great, if not greater potency in the production of endemic diseases. The facts, however, in this instance, as well as in the former, are opposed to such a conclusion.

Let us take, for instance, that town in the West Indies where the density of population is the greatest, and where poverty and filth most abound—viz., Bridge-town, Barbadoes—and what shall we learn? That it is precisely here where endemic fever is unknown. Turn, again, to Port of Spain, Trinidad, hemmed in on each side by a pestiferous swamp, and what will be observed there? That individuals, and even strangers, can reside in this town with comparative impunity and without being attacked with endemic fever. But let the same persons take up their abode, for a single night, on the La Ventille hill, in the immediate neighbourhood, overlooking the magnificent Bay of Trinidad, large enough to contain all the fleets in the world, and what will then be the consequence? an attack of fever in its severest form. In fact, a military post, formerly established there, had

* "If the 135 sub-districts," observe the writers of the Report, "are arranged in the order of their density, the result is similar."

† Report of Committee for Scientific Inquiries. 1854.

to be abandoned from this very cause.* If, also, from intertropical regions we turn to northern ones, where disease, it is true, is less rife, but where it still prevails to a considerable extent, another series of facts will be presented to our notice. In Russia, every precaution is taken, during the winter months, to keep out the external air, by double doors, windows, &c.; while, with the lower orders, a large number of persons will be crowded together in the same room, heated to a temperature little short of that of an oven. But fevers are unknown at this period: it is not until the return of summer, when the doors and windows are opened, so as to admit the free ingress of the external air, that this class of diseases is to be met with. The same result is observed, and in a more remarkable degree, with the natives of Kamschatka. The inhabitants of these regions dwell, during seven months in the year, in what are called Yaurts, a sort of cabin sunk seven or eight feet below the surface of the ground, and covered with a thatched roof, in the form of a truncated cone, open only at the top. Six families with their store of provisions, chiefly fish, and often half putrid, will be found in one small apartment. The Greenlanders and Esquimaux, also, live in close, crowded habitations, without any chimney; yet, all these classes of persons, as we are informed by Dr. Chisholm, are almost entirely exempt from fevers and epidemic diseases.

It is not necessary, however, to go to the frozen regions of the North, or to the pestiferous spots of intertropical climates, in order to prove that density of population is not a predisposing cause of disease. The statistics

* The *summit* of this hill, which, it may be observed, is formed of lime-stone, and 400 feet high, is so deadly a spot, that not even a Creole Spaniard could sleep there with impunity for a single night.

of that town, where this doctrine had its origin, will alone be sufficient to negative the conclusion. If we refer to Table 2, previously inserted, and to the column for ordinary mortality, we shall find that the ratio varies but little between one district and another, although the difference in the number of persons to an acre varies from 4 to 282. It will doubtless be said that there are other and disturbing causes in operation in these instances; that is no doubt the case in some, but not in all. Take Wandsworth, for instance, or St. James's, Westminster—the two healthiest districts—and then compare them with that focus of all the abominations on the face of the earth—Lambeth—and what is the result? A difference of mortality of 35 in the first case, and of only 21 in the last, in 10,000 inhabitants. Again: let us contrast district 9, where there are 19 persons to the acre, with districts 1, 2, and 3, where there are respectively 282, 222, and 202 to the same area, and what do we learn? That the ratio of mortality is actually higher in the former than in the latter. So, also, if we compare district 5, where the mortality is greatest, with district 1, where the density of population is greatest, and where the mortality is 33 per 10,000 less, it will be seen that the ratio of population in the former is only half what it is in the latter. Let us extend this inquiry, and compare London with the country districts, where the difference as regards density of population is so great. For this purpose, we must turn to Table 1, and to the column of mortality from all causes. We shall then find that the difference in the rate is only a fraction of 4 between London and the district where the density of population is the least, although there is a variation in this respect of 234 persons to the 10 acres—viz., 9 and 243. The above districts are, it is true, all more or less unhealthy; but

then, if we refer to the next and intermediate group, where the density of population is a trifle greater than in the first group, and where all the districts are healthy, there will then be only the difference of a few fractions—9 instead of 4.

It is thus established, in a manner which admits of no doubt, that density of population is not a predisposing or exciting cause of disease. Mr. Howard, the philanthropist, after his extensive experience, was also obliged to look "for some other cause than overcrowding in order to account for the production of gaol fever." Dr. Bancroft, also, in his work on Yellow Fever, combats the opinion that fevers are produced either by accumulations of those disgusting matters commonly termed filth; by the offensive vapours emitted by putrefying dead bodies, or by other matters in a putrid state; or by *crowding persons*, when healthy, in ill-ventilated and unclean places.

That the congregation of men and animals in a limited space, as in a town, cannot be productive of disease may also be shown by a consideration of the changes that take place in the air by respiration. These are, as is well known, the absorption of a certain portion of the oxygen of the air, and the formation of a definite quantity of carbonic acid gas, by the union of the former with the carbon of the blood. We are still in ignorance of the precise manner in which this vital operation is effected; all we know is, as the result of direct experiment, that the quantity of oxygen contained in the carbonic acid gas expired is somewhat less than that of which the air has been deprived; the rest of the oxygen, therefore, must have been converted to other purposes in the economy. We can thus account for what has been termed the vitiation of the atmosphere by respiration, or, in other

words, the loss of its oxygen, and the substitution of a certain amount of carbonic acid gas. In addition to this, aqueous vapour, and certain volatile substances, particularly those which have been taken into the stomach, are given off at the same time; hence the odour of the breath from spirits, garlic, &c. Sometimes putrescent matters are also present in the expired air, but this is an exceptional case; in general, no deleterious substances, similar to those which exist in the different excretions, pass out of the system by this channel. All that we have to do, therefore, in considering the physiological properties of expired air, is to inquire into the effect produced by the loss of the oxygen, and the addition of the carbonic acid.

That the loss of the former cannot be detrimental, we may infer, not only from the preceding facts, but, also, because this gas is found to be in its normal proportion in those districts where disease prevails to the greatest extent. M. Deveze remarks, that an analysis of the air of the most healthy places gives the same result as that of the most unhealthy, for chemists have obtained in each 78 parts of nitrogen, 21 of oxygen, and 1 of carbonic acid. This was the case with M. Jules-Cesar Gattoni, who analyzed the air of the putrid marshes of the Fort of Fuentes, at the mouth of the Valseline—a country in which a stranger cannot sleep without being seized with fever, and that on the top of Mount Lignoni, always covered with snow, and 8,000 feet above the level of the sea. "This result is the more remarkable," observes this experimentalist, "as the inhabitants of the former localities, abounding in rice-fields, are walking corpses, affected with fever the greater part of the summer, and not living beyond fifty years; whereas the neighbouring

mountaineers are strong and vigorous, with a fresh complexion, while they live sometimes to a hundred years." * As the loss of the oxygen, therefore, cannot be an exciting cause of disease, it only remains to ascertain the effect of the carbonic acid when diffused in the atmosphere. This, however, has been already done, while it has been inferred that the presence of this gas in the air, in those proportions in which it usually exists, acts, not as a promoter, but as a preventive of disease. This circumstance will enable us to explain certain facts that must otherwise be considered as anomalies, while these facts, in their turn, confirm the conclusion just drawn.

In my two Reports—the published and the unpublished one—a number of facts have been adduced in order to show that the congregation of men and animals in a confined space appeared to prevent the spread of cholera, either by lessening its ravages, or by preventing an outbreak. It is unnecessary to adduce those instances on the present occasion; it will be sufficient to show that the same result is sometimes observed with endemics as well as epidemics. This will not be a matter of much difficulty, for the proof can be obtained in the spot where I now am.

In Rome, the chosen seat of malaria, it is a fact of common notoriety, that the healthiest spots are the most populous, and the open, cleared spaces, the most unhealthy. Many of the villas of the rich are nearly uninhabitable from this cause—as the Villa Borghese, for instance, standing in its own park-like grounds—while it is invariably found that the pulling down of houses and making a clear, open space will convert a previously healthy district into an unhealthy one. That these results are to be ascribed to some cause connected with popu-

* Memoires de la Société de Médecine, Paris, t. 10, p. 109.

lation, and not to any other or accidental circumstance, many facts clearly demonstrate. For instance, several of the monasteries and convents are situated in the more elevated and unhealthy parts of Rome; yet the inmates, although the environs are all but uninhabitable, reside there with comparative impunity. If, however, they become untenanted from any cause, it is then found that the place is uninhabitable, or dangerous to the servants or others left in charge. The same fact is observed with the villas of the rich if they become abandoned from any cause by the family. So, again, the decrease of population in a district, without any other change in its physical conditions, is invariably found to render it more unhealthy than before; while, on the other hand, the increase of population *alone*, in the same or other districts, is attended with a proportionate decrease in the prevalence of fever.

It is not surprising, therefore, that M. Michel should have laid it down as a principle, or a law, that population decreases the insalubrity of a town like Rome.*

But it is not in Rome only that this result has been observed: the same fact is apparent in other situations, as in London; for ordinary fever has decreased in this town, in an inverse ratio with that of population. In 1660, it was calculated that there were 120,000 souls within the walls, while it is stated that there were from 5 to 600,000 within and without in 1700; but, notwithstanding, there was no return of plague, which ceased in 1665.† In addition to this, there was a very remarkable

* Récherches Médico-Topographiques sur Rome.

† Speaking of the Plague, it may be as well to correct a very erroneous impression that prevails, as regards the disappearance of this disease in London, it being generally asserted that the latter fortunate result was due to the great fire that occurred in 1666. It

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diminution in the prevalence of the ordinary forms of fever—continued, remittent and intermittent. Not only were the two first forms of fever very prevalent and very fatal during the whole of the 16th century, but ague, also, was then more common and more fatal than it now is in Rome. I have no account of the mortality during the 17th century, but there was a considerable diminution in all the forms of fever towards the end of the 17th century, as we may learn from the bills of mortality, for in 1700 the deaths from fever were only 2,902. Notwithstanding the increase of population during the 18th century, which, at the end of this period, was calculated at 747,043, within the bills of mortality, the number of deaths from fever continued nearly the same, being 2,292 in 1750, and 2,713 in 1800. But from this period up to 1832, when the population had more than doubled itself, there was a remarkable diminution in the number of deaths from fever—a diminution that would be still more

is an undoubted fact, that no plague has appeared in London since that memorable event, the last visitation having been in 1665,—a year previously; but then it is no less a fact that the disease subsided, at the same time, in every other part of England, and in all the north of Europe. We have thus another and a striking example of the common fallacy of confounding the *post hoc* with the *propter hoc*. Another mistake, connected with this fire, has been made by Mr. Simon in his last Report. He states that ague was always endemic in London, before the great fire in 1666, whereas now it is unknown; leaving his readers to infer that the disappearance of the disease and the appearance of the fire were contemporaneous. Nothing can be more erroneous than such a conclusion, for ague did not disappear from London until the middle of the 18*th century*. Not only did this disease prevail during the latter end of the 17th century and the first part of the 18th; but it was epidemic in London in 1751, in 1753, and in 1754. All that can be said is that ague, which was very general and very fatal in the 15th and 16th centuries, *gradually* subsided in the 17th and 18th centuries, until it became extinct. The bills of mortality will prove this.

striking, if we were to calculate the ratio of mortality according to inhabitants. Thus in 1810 the number of deaths had diminished from 2,713, in 1800, to 1,139: in 1820, there were 1,109 and in 1830, only 782. The numbers, it is true, have again increased since 1832, but this increase has arisen, not from endemic fever, but from Typhus, which must be regarded as an epidemic. More than this, we may ascribe it to the same cause as that which produces the epidemic cholera, not only because the unusual prevalence of the one and the commencement of the other are to be referred to the same date, but, also, because fever has been the invariable accompaniment of the epidemic cholera. Thus, in Spain, intermittents were epidemic the winter after the subsidence of cholera, as they were also in Austria, and many other parts of Europe. In the West Indies, remittent fever followed the outbreak of cholera, appearing, also, in those places not visited by the epidemic: and, what is more singular, it prevailed among the black population, a class of persons who, under ordinary circumstances, are exempt from fever. That the greater prevalence of Typhus in London, during the last 25 or 30 years, is not to be referred to increase of population, we may infer not only for the above reasons, but also from the fact, that the disease has prevailed to as great an extent in other parts of the kingdom and in those towns where there has been little or no increase of the population. The prevalence of this disease, like that of the epidemic cholera, merely shows that we have arrived at a new period in the medical history of the world—an epidemic period—characterised not only by disease and pestilence in the animal and vegetable creation, but also by disturbance in the physical world, as it has been my object to show on previous occasions.

These conclusions are confirmed by another fact; the diminution in the annual mortality before referred to, has not been confined to fever, but has also been observed in other and the majority of diseases. In the 17th century, the annual deaths from bowel complaints, of which dysentery (a disease now almost unknown in London) was the principal, amounted to from 1,000 to 2,000; while, in the first part of the 18th century, they fluctuated from 1,000 to 100, and in the latter part of the same period from 100 to 20.* We observe the same striking result as regards the *ratio* of mortality. In the Parliamentary returns for 1811, it is stated that the annual mortality in 1700 was 1 in 25; in 1750, 1 in 21; in 1800 and the four preceding years 1 in 36; and in 1811, 1 in 38. The value of life, therefore, increased 11 per cent., during the past century. This result has not been confined to London, but has also occurred in other towns, under the same circumstances. In Manchester, according to Dr. Perceval, the rate of mortality was 1 in 25·7 in 1759, and 1 in 28 in 1770: but in 1811 it was only 1 in 74, while the population, in the two former periods, was not quite one-fourth and one-half what it was in the latter period. We observe the same diminution in the mortality of children, who are so susceptible to the influence of all morbific agents. Between the year 1728, when the ages were first marked, and the year 1738, the number of deaths, under two years, amounted, upon the average, to 10,000; in the next decade to 9,000; in the following to 7,800; and between 1790 and 1800 to little more than 6,000,—being a diminution of 4,000 in the year, in less than a century. †

It is thus clear that the changes which are produced in

* Sir Gilbert Blane. Select Dissertations.

† Hebberden's Commentaries. P. 33.

the air by man, during respiration, or in other words, the formation of carbonic acid, and its presence in the atmosphere, so far from predisposing to disease, have the very contrary effect. It only remains, therefore, to consider the next and last item in the list of exciting causes, —the influence of impure water.

It has been concluded by the writer of the Bengal Report and others, that the use of the water of certain nullahs—artificial ponds made for the reception of rain-water, and which, remaining from one rainy season to the other, contain a large amount of organic matter—has caused, or predisposed to attacks of cholera. Such is possible; but as these effects were observed in a country where not only epidemic but sporadic cholera is very common, no inference can be drawn from such facts: the occurrence of cholera and the use of the water may have been merely coincidences, without the one being the cause of the other.

Much stress has also been laid of late on the influence of Thames water in the production of the epidemic cholera; not only on account of its impurity, but also from the fact that the disease prevailed to a greater extent in those localities supplied with Thames water than others, during the two first visitations. The prevalence of cholera in Bermondsey was ascribed by Mr. Bowie to the quality, or, rather, the impurity of the water; and the outbreak in Rotherhithe to the same cause by Mr. Grainger. Dr. Gavin also stated that "the connexion between foul water and cholera was established by *irrefragable evidence*."* It becomes an important question, therefore, to ascertain if this conclusion be a just one.

That the water of this river contains a large amount of

* Report of the General Board of Health on the Supply of Water to the Metropolis, 1850.

extraneous matter is apparent to every one, while the source whence it is derived is equally clear. In addition to the alluvial and vegetable matter which it brings down from various sources—in common with all rivers—there is the sewage water of London and other towns, as well as the refuse from a multitude of manufactories which line the banks of the Thames. In the water of this river, therefore, we shall find the ordinary products of the decomposition of organic matter, as also those usually existing in cesspools and sewers; together with a variety of substances from the above manufactories, some of an innocent and others of a noxious quality,—as, for instance, carburetted hydrogen from the gas works, arsenic and other direct poisons from certain works that it is unnecessary to name. The latter ingredients, when in sufficient quantity, would necessarily produce deleterious effects with those who made use of the water; but as these effects would be specific and peculiar to each substance, and different from those common to ordinary diseases, their consideration would be foreign to the present inquiry. All that we have to do now is to ascertain if the organic matter which is present in the water of this and other rivers can be productive of cholera, or any other general disease.

I would observe, in the first place, that in order to produce any injurious result, the matter must be in a state of decomposition at the time; for it is not the matter itself, but the products of its decomposition, that are injurious. The question, therefore, is, do these products exist regularly, and to any great extent, in the waters of a river like the Thames? The answer to this must be in the negative; and for this simple reason, that although a small quantity of water favours the process of putrefaction, a large quantity prevents it. A high temperature is also necessary to produce the decomposition

of organic matter in water; but this is not found, under ordinary circumstances, in such a climate. That the vegetable and other matters contained in the water of the Thames, only become partially decomposed, and to a very small extent, may be shown by the following facts. Those who have made a voyage to India, by the Cape of Good Hope, in a ship supplied with Thames water, will know that this remains sweet, or, in its usual state, until after the ship has reached the tropics; when, in consequence of the increase of temperature, the matter in suspension undergoes speedy decomposition. It is therefore necessary to allow the water to stand for some time before it is drunk, to allow the gaseous products to pass off; but it will necessarily retain a portion of the gases; and hence the free use of spirits to cover the slightly nauseous taste. This process will be renewed three or four times, after which it becomes the finest water in the world for flavour; and nothing is considered a greater treat than a glass of Thames water on the homeward-bound voyage. Now it might be inferred, that those who partake of this water, under these circumstances, and when the process of putrefaction was going on to so considerable an extent, would suffer in consequence; but such is not the case; for the crews of ships are invariably most healthy during the voyage from England to India. If, therefore, no injurious results are experienced under such circumstances, it is not probable that any will arise when the water has been recently taken from its source; particularly when we remember that the supply for ships is derived, not above, but below bridges, and from the docks.*

* We are told by Dr. Bancroft, that in the Greenland ships the water for the outward-bound voyage is put into the casks which before contained the blubber, but although it becomes more or less putrescent, the men always enjoy good health.

That the organic matter contained in this river does not undergo decomposition to any extent, under ordinary circumstances, may be inferred from the fact that Messrs. Brand, Cooper, and Taylor failed to detect either sulphuretted hydrogen or the hydro-sulphuret of ammonia (the ordinary products of cesspools) in Thames water. Were it otherwise, however, it is apparent from the conclusions previously drawn, when considering the properties of the products of the decomposition of organic matter, that they could not, when taken into the stomach, produce cholera, fever, or any ordinary disease. This conclusion is strengthened by what has occurred during the past year; for in consequence of the unusual heat and the great drought—by which not only the quantity of water in the river was lessened, but a larger surface of the muddy banks also exposed—decomposition took place to an unusual extent; while the evolution of gaseous matter was greater than had ever been experienced before. But no visitation of cholera, or other disease, has been experienced.* If, however, such had unfortunately been the case, it would have been no proof that the disease was caused by the use of the water, without some other and direct evidence in support of the conclusion; for, as it so happens, the districts supplied with Thames water are worse situated, in a sanitary point of view, than any others in London. As Macculloch has rightly observed, while referring to this very subject; whatever accessory

* Instead of an increase of disease there has actually been a diminution this year. According to the Registrar-General's Return, the mortality for the last week in August, in London, was 1,108, while the average for the same period for the last ten years is 1,261. Calculated according to increase of population, the same rate of mortality would have given 1,387 deaths, so that there has been a diminution of 279 in the week. Although not quite to the same extent, there was also a considerable diminution in the rate of mortality for the whole month of August.

ill-effects may be produced, it is always forgotten that this bad water occurs only, or chiefly, when the land is of such a nature as to be in itself a source of malaria.*

That the impurity of Thames water has not a very injurious result on the health of those who take it, may be inferred from the slight variation that is observed in the ratio of mortality, from ordinary diseases, in those districts supplied with Thames water and those that derive their supply from other sources. I have not the means, at the present moment, of making a general comparison, and must therefore content myself with a partial one. The quality of the Thames water, we find, varies greatly according to the part of the river from which it is taken. By the analysis of Dr. Haslam, the Thames-Ditton water, supplied by the Lambeth Company, is by far the purest; while that of the Southwark and Vauxhall Company is, with the exception of Chelsea, the worst—the relative degree of purity being 13·36 for Lambeth; 45 for Southwark and Vauxhall, and 60·17 for Chelsea. Now if we turn to Table 2, previously inserted, and observe the ratio of mortality, from ordinary diseases, for Lambeth and Southwark, we shall find that the difference is only 47 for 10,000 inhabitants—not quite half per cent.—taking the average of the three districts for Southwark. This difference would be still less if the deaths from the two great hospitals, situated there, were excluded.†

So, again, if the impurity of Thames water had any

* On Malaria.

† In a letter inserted a short time since in one of the public journals from a surgeon in the district, it was stated that the *ratio of mortality* in Southwark, if the deaths at Guy's and St. Thomas's were excluded, which, of course, they ought to be, *is not* higher than that of the other districts in London. Having mislaid the note, I am unable to give the name of my authority, or even that of the Journal; but the fact was as I have stated.

influence in the production of cholera, we should have expected that the disease would have prevailed, to the greatest extent, in that district in which the water is the most impure. Such, however, is not the fact, for Chelsea, the worst of all, has been less severely visited than Lambeth, or any of the other districts supplied with Thames water. Besides, if the quality of the water exerted any material influence in the causation of cholera, the same result ought to have been observed at each visitation; particularly as the state of the river is worse now than what it was formerly. But Southwark, although the first in the order of mortality in 1832, was the third in 1849: while the same variation was observed in all the other districts at the latter epoch.

With respect to the greater prevalence of cholera in the districts supplied with Thames water than in others, the fact admits of explanation without reference to the quality of the water. In a previous publication, I have laid it down as a law, regulating the march of epidemic diseases on the surface, that they prevail to the greatest extent on tertiary formations and alluvial soils—and particularly at the mouths and on the banks of rivers—less on secondary strata, and not at all on primary formations. This rule will be found to hold good, no matter whence the inhabitants derive their supply of water for internal use: whether from the river that flows at their feet, from wells, or from the heavens above, as at St. Thomas, the inhabitants of which use rain-water, and where, be it observed, the ravages of the disease were as great as in any part of the West Indies.

There is, also, another circumstance that must be taken into account, while considering the influence of such a cause in the production of the epidemic cholera. This is what I have termed the Law of Progression. It is

in consequence of the operation of this law that the disease, although prevailing to the greatest extent in low, alluvial districts, and particularly on its first appearance, will, in subsequent visitations, leave these situations and attack more elevated and healthy districts. This was particularly apparent in India, the disease commencing in the low and alluvial province of Bengal, but subsequently ascending, and step by step, and year by year, the more elevated parts of the country, until it ultimately reached the highest inhabited ranges of the Himalaya mountains. The same phenomenon, although to a trifling extent, has been observed in England during the two last visitations.

At the commencement of the outbreak, in 1848, I met my friend Dr. Conolly, of Battersea, and inquired of him if there were any cases of cholera in his neighbourhood. His reply was,—"No! and, what is more, we shall have none; our district is too healthy; in addition to which we escaped entirely in 1832." "That," I replied, "is precisely the reason why you will be attacked this time." And so it proved; for the Wandsworth district was visited as severely as some of the low-lying districts, and more so than many of the unhealthy ones in London. In the last visitation, that of 1854, the disease expended its fury, not in the districts on the bank of the Thames, as in 1832 and 1849, but in the somewhat elevated and more healthy parish of St. James —the very district that had the lowest rate of mortality in 1849, as will be evident by a reference to the Table of Mortality previously inserted. This result, which has occasioned much surprise and comment, is only what had been previously predicted by me. In a conversation that I had with Dr. Farr, on my return from Jamaica in 1852, and while referring to the greater prevalence of cholera

in the hilly districts of that island, I stated my conviction that the disease would ascend to the more elevated districts in London during subsequent visitations, and particularly if it assumed a more severe form.

As the result of the operation of the same law, we observe the disease attacking one town, or a particular part of a town, during one visitation, and another town, or the remaining part of the town, during the next. This has been so common a result during the march of the disease from Asia to Europe, that it is unnecessary to cite the examples. It will be sufficient to know that the same phenomenon has been apparent in London, and in the very districts supplied by Thames water. Thus, Rotherhithe, which was the first in the order of mortality in 1849, was only the ninth in 1832; Bermondsey, the second in 1849, was the fourth in 1832; Southwark, the third in 1849, was the *first* in 1832; and Newington, the fourth in 1849, was the sixth in 1832, and so on.* With such facts as these before us, we may conclude that the use of Thames water, bad as that water undoubtedly is, had no influence in the production or spread of the epidemic cholera.

It follows, therefore, as the deduction from the preceding data, that neither the products of decomposing matter on the surface, nor the alteration in the air by overcrowding, nor the use of impure water, have any influence in the production of those two classes of disease termed epidemics and endemics. This is a conclusion at which we might have arrived *à priori*, and from a simple consideration of the fact, that these diseases not only prevail in all situations, but they also present the same pathological symptoms in each; while the causes that have just been considered vary in different localities, if

* Report of General Board of Health. 1848-9.

not in each separate locality. How, then, can uniformity of effect be produced under such circumstances? for, it ought to be borne in mind that, although fevers present a variation of form or type, other diseases do not; at the same time that the variation observed with the former can be accounted for simply by the difference of temperature. Mr. Simon, however, tells us, that all kinds of organic matter produce the same result. "Whence they may be derived signifies little. Whether the matter, passing into decay, be an accumulation of soaking straw and cabbage-leaves, in some miserable cellar, or the garbage of a slaughter-house, or an overflowing cesspool, or dead dogs floated at high water into the mouth of a sewer, or stinking fish thrown overboard at Billingsgate-dock, or the remains of human corpses undergoing their last chemical changes in consecrated earth, *the previous history* of the decomposed material *is of no moment whatever.*" * With all due deference to this writer, it is of very great moment; for there is a very material difference in the chemical results of vegetable and animal decomposition, and a consequent variation in their effects on man. This must be apparent from the facts already detailed, and it will be still more so from a further and a slight consideration of the subject.

Setting aside the use of impure water, which, if detrimental, must be entirely local in its influence, as also, overcrowding, which it has been shown, so far from being a predisposing cause of disease, produces the opposite result; let us inquire, if there could be anything like uniformity of result produced by the other causes that have been considered. That would appear to be impossible, on the first glance at the question. We have seen, for instance, that the products of the putrefaction of night soil

* Loc. Cit.

are different from those which arise from the decomposition of animal and vegetable substances; while these differ again, at least when the process takes place underground, from those which are the effect of the decomposition of human bodies. Then, again, there is a great difference in the result of the decomposition of animal and vegetable matter; while there will also be a variation when the matter undergoing decomposition is a mixture of the two substances. Not only will one gas be present in the one case, and be absent in the other; but the proportions of each, when present, will vary at different times, and in different situations. And yet Mr. Simon tells us that it is immaterial what the matter is, and whence it be derived. Is that probable? Is it, I may ask, possible? Can the same invariable effects be produced by so many different agents? We do not meet with such a result in daily practice. When an individual takes a dose of arsenic, prussic acid, or other poison, we do not observe fever, or cholera, produced in all these instances, but a train of morbid effects peculiar to each; so much so, that we know, simply by the effects, both in the living and dead body, what the substance is that has been swallowed. So, again, when a particular gas has been inspired, it produces, as we have seen, when speaking of the chemical and toxicological properties of the products of putrefaction, peculiar and uniform effects. As we observe the same uniformity of pathological phenomena with diseases, we must infer that they are produced, at all times and under all circumstances, by the operation of a poison of the same nature, composition, and uniform strength. But this would be impossible, if all the causes that we have been considering are productive of general diseases. Dr. Smith has attempted to remove these objections to his theory, in the following way:—he remarks, while referring to the noxious

influence of decomposing matter, "it is equally well known, that when the air is infected by particles of decomposing vegetable and animal matter, fevers are produced, of various types and different degrees of intensity; that the exhalations arising from marshes, bogs, and other uncultivated and undrained places, constitute a poison, chiefly of a vegetable nature, which produces fevers of an intermittent or remittent type; and that exhalations accumulated in close, ill-ventilated, and crowded apartments in the confined situations of densely-populated cities, where little attention is paid to the removal of putrefying and excrementitious matters, constitute a poison, chiefly of an animal nature, which produces continued fever, of the typhoid character." *

These conclusions are the most gratuitous, and the most opposed to daily experience, that can possibly be. Typhus fever will attack the solitary individual in an uninhabited district, the same as the inhabitant of the populous town; while, on the other hand, intermittent fever is to be met with in towns, as well as among fens and marshes. It has been already stated that agues were one of the epidemics of London; while I may add, that this form of fever not only prevails at Madrid, but it presents the same type and character as in the alluvial plain of Valencia, abounding in swamps and rice fields. Yet Madrid is situated on a dry, sterile, and calcareous plain, at an elevation of 1,200 feet above the level of the sea; not only fens and marshes but vegetable matter, also, must be entirely absent in such a situation. † On the other hand, the severest form of

* The Practice of Interment in Towns, by E. Chadwick, Esq., p. 19.

† Dr. Ferguson, whose deductions were drawn, not from theory, but as the result of long experience in intertropical and malarious countries, has arrived at a very different conclusion from that of the preceding writer. He remarks, "That the marsh poison cannot emanate from

continued fever is more frequently met with in uninhabited districts, in the alluvial tracts of intertropical climates, precisely there where vegetable matter most abounds. But, although there are different forms of fever, it is to be remembered that there is no such variation with other diseases, which invariably present the same character and symptoms, at all times, and in all situations. For instance, the epidemic cholera, the symptoms of which, and the pathological phenomena, are as characteristic and as uniform as those produced by a dose of prussic acid. If we were to take an individual, labouring under the severe form of this complaint, and who had been attacked in the Sunderbunds of Bengal, and another, in the Desert of Arabia; with a third from the Steppes of Russia, when the ground was covered with snow and ice; and then lay them side by side, it would be impossible to distinguish the one from the other, merely from the symptoms and the pathological phenomena present. And yet, how different must have been the local causes in operation, in these respective instances. In the one case, the products of the decomposition of organic matter were present to the greatest possible extent: in the others, they were entirely absent; in the one instance, because no organic matter was present, and, in the other, because the process of putrefaction could not take place under such circumstances. More than this, the disease prevailed equally in

vegetable production, I think must be evident, from the fact that it is found *most virulent* and abundant on the driest surface, often where *vegetation never existed*, or could exist for the torrents, such as the deep and steep ravines of a dried water-course; and that it is never found in savannahs and plains that have been flooded in the rainy season, till their surface has been thoroughly exsiccated, *vegetation burnt up*, and its putrefaction rendered as impossible as the putrefaction of an Egyptian mummy." (Loc. cit.)

all these situations; with this one difference, that it was more intense precisely in that situation where organic matter was wanting; for nowhere have the ravages of the epidemic cholera been greater than on the arid and sandy plains of Arabia. How farcical then,—or worse than farcical, how detrimental to the advancement of science, and the best interests of humanity,—to proclaim thus constantly and openly, and with the voice of authority, that this disease is to be ascribed to the accumulations of organic matter on the surface.

There is also another circumstance that should be taken into account. The above causes are more or less constant in their operation; but epidemic diseases only occur at stated periods and at long intervals. More than this, the epidemic cholera is a new disease, never having been observed in India until 1817, or in England until 1830. In order, therefore, to get over these difficulties, the writers referred to have added a clause to their theory, and have drawn, not only on their own imagination, but on the credulity of their readers, by inferring that a sort of ferment, or *zymotic* matter, has been transported beyond the seas; and that the addition of this leaven to accumulations of organic matter has produced a compound to which the evil is to be ascribed. "That which seems to have come to us from the East," observes Mr. Simon, "is not itself a poison, so much as it is a test and touchstone of poison. Whatever in its nature it may be, this, at least, we know of its operation. Past millions of *scattered* population it moves innocuous" (as, for instance, the scattered population of the Caucasus, where 16,000 were attacked, and 10,000 died, out of 24,000 inhabitants). "Through the unpolluted atmosphere of cleanly districts it migrates silently, without a blow; that which it can kindle into poison lies not there" (as in the deserts of

Arabia; but where, notwithstanding, those who were thus inhaling the unpolluted atmosphere were cut off like so many rotten sheep). "To the foul, damp breath of low-lying cities it comes like a spark to powder." (In London, however, the explosion of the powder-magazine did not produce very serious results:—14,000 deaths out of a population of two and a-half millions.) "Here is contained that which it can swiftly make destruction—soaked into soil, stagnant in water, griming the pavement, tainting the air—the slow rottenness of unremoved excrement, to which the first contact of this foreign ferment brings the occasion of changing into new and more deadly combinations." *

Supposing, for argument's sake, that these effects could be produced by such a cause, how, we may ask, was this zymotic matter, or poison-cloud, as it has been termed, transported from the East to the West? By the winds? Assuredly not; for this disease has progressed as regularly against, as with the wind. Across the continent of India it travelled at the rate of a degree a-month—its progress being the same against as with the strong and violent monsoon. Again: the epidemic took seven years to traverse the mountainous regions of the Caucasus, progressing regularly, step by step, and year by year, until it reached the steppes of Southern Russia, when its progress was as quick as it had previously been slow. Now, if a poison-cloud had been in the air of these localities, would it not, we may ask, have been dispersed, in the same number of months, to the four quarters of the globe? Such assuredly would have been the case; and we may therefore conclude that this winged messenger of death has no existence, excepting in the fertile imagination of those who required a pivot on which to hang

* Fifth Report for the City of London.

with her all the decomposing matter that previously existed; how, then, I would inquire of these theorists, will they account for the sudden cessation of the disease on board the frigate? It cannot be accounted for by a reference to their theory.

There is another phenomenon, which the advocates of this theory would do well to consider, and might be called upon to explain. This is the occurrence of disease among the inhabitants of the deep, who frequently die in large numbers during epidemic periods, as was particularly remarked during the prevalence of the Black Death of the 14th century, and, also, since the appearance of the epidemic cholera—a circumstance I have dwelt on more particularly in another place.* This mortality occurs not merely among those small species that inhabit rivers, lakes, and ponds, but, also with those ocean leviathans that are only found at a distance from land, and, therefore, removed from the operation of all those local causes that affect the inhabitants of the dry land. Will these theorists tell us that the decomposition of organic matter is going on beneath the waters of the ocean, and that the ferment has descended to the bottom of the mighty deep? I know not what their answer may be; but, before giving one in the affirmative, I would recommend them to study another subject; and this is the occurrence of

* The subject of the epidemic constitution upon animals, was brought before the Faculty of Vienna, by order of the Imperial Government. They remark in their Report, subsequently published, after referring to the fact of all classes of animals being more or less affected, that although the peculiar agency is still problematical, yet it appears satisfactorily proved not to depend exclusively on the condition of the atmosphere; since animals, that live in water only, as fish, crabs, leeches, &c., died in great numbers, at the time of the cholera epidemic. (Dated Feb. 14th, 1834.)

disease in the vegetable creation,—as for instance among the potatoes.

That this vegetable epidemic is due to the same cause as that which produced the epidemic cholera, it has been my object to show in a separate essay: while, also, I have attempted to demonstrate that the two diseases are the effect of *one and the self-same poison.* Are we, therefore, to refer this disease to organic decomposition, or to another and a different cause? If the former, we should have to inquire how it happened that those products of putrefaction, some of which serve those plants for food, while the remainder prove perfectly innocuous at ordinary periods—for plants, it should be remembered, not only live but flourish in the midst of decay and putrefaction, as pigs live and thrive in the midst of filth—are suddenly converted, from the elements of life and health, into the elements of disease and destruction! If, on the other hand, we ascribe the disease to some other agency, the preceding theory falls at once to the ground; for if there be some general cause in operation, irrespective of organic decomposition on the surface, causing disease and death in the vegetable creation, we cannot fail to refer the production of analogous effects in man to the same agency, as it is not probable that there will be two causes in operation, at one and the same time, productive of the same, or similar results. We may therefore conclude that this supplemental theory, like that applied to the production of endemic diseases, is insufficient to account for the origin of epidemics: as such we will return to the subject that more immediately concerns us, the causation of endemics.

Having attempted to show that the prevalent theory of the day is an erroneous one, it is necessary to inquire what are the real and efficient causes of this class of

diseases—for that is the great desideratum at the present moment. It would be superfluous on this occasion, to enter into a detail of the different theories that have been broached, from the time of Hippocrates to the present day, in order to account for the production of general diseases. Suffice it to be observed, that a distinction was generally made, by ancient writers, between epidemics and endemics, for while they referred the first to some cause existing in the air—according to the aphorism of Hippocrates, *aer est omnium rex morbarumque causa*—so, on the other hand, they ascribed endemics to some cause existing in the soil, or to the exhalations which are given off from the surface of the earth.* This fact has been dwelt on more particularly by the Roman and Italian writers; for Italy has always been what it now is, the chief seat of fever, and other diseases belonging to the same class.

But, although we are indebted to Italy for our first precise knowledge of the existence of this morbid agent —to which the term malaria (mala aria, or mal' aria) has been applied by modern Italian writers, and that of marsh-poison by English ones—it has been during the past half century, since the extension of England's colonial empire, and during the employment of our troops in all the unhealthy quarters of the globe, that the subject has been more profoundly studied, and the mighty influence of malaria on the health of man better and more fully understood. It is, in fact, to the works of those modern English writers who have adorned the ranks of our army and our navy that we must turn, if we wish to make ourselves fully acquainted with this important subject.

* Hippocrates was the first to draw attention to the subject of endemic diseases, and to the insalubrity of marshes and similar localities.

That a something is given off from the surface, or that some substance exists in the air of particular localities, productive of disease and death, is shown by a variety of circumstances. Thus, if an individual, coming from another and a more healthy locality, takes up his abode near to, or in, a malarious district, he will be attacked with intermittent, remittent, or continued fever, according to his position, the climate, and other local circumstances. In the expedition to Walcheren, in 1809, the troops were landed on the 1st of August. Flushing capitulated on the 15th, and the bulk of the army returned to England the beginning of September, leaving 18,000 men to garrison Walcheren. "Of this number, more than *one-half* died or were sent to England in the course of the three following months." * Let us take another example. A ship bound to the East Indies, passes through two or three climates, exposed to the calms and heat on the line, and the cold and tempests of the Cape of Good Hope. Its hygienic state is, probably, none of the best, being deprived of the use of fresh provisions, with, possibly, half putrid water, and crowded with passengers, soldiers, and sailors. Yet all these individuals will preserve their health during the whole voyage, extending over a period of three or four months: this, it is to be remarked, being not an accidental circumstance, but the general rule. As soon, however, as the ship has anchored in the Straits of Sunda, opposite to some extensive swamp, and near enough to smell the land breeze at night; † or, in one of the branches of the Ganges, among the Sunderbunds of Bengal, surrounded by marshes

* Sir Gilbert Blane "Mission to Walcheren." P. 226.

† On the coast, and in the islands of intertropical climates, there are two different and regular winds experienced—called the sea breeze and the land breeze—the effect of the difference of temperature be-

and jungles, what will then be the result? In three or four days—sometimes in a few hours—a number of persons will be attacked with fever, &c.; while the character and type of the disease will be different from anything experienced before. On the other hand, if the ship takes her departure, and proceeds to sea, these effects will cease. We are thus certain, that a something exists in the air of such localities; for there is no other way in which we can account for the effects produced—the individuals thus attacked having been exposed to the same degree of heat, hygrometrical and other conditions of the atmosphere, previously, without having experienced any injurious result. More than this, we also know that the agent is not diffused generally in the air, or at least in the same states of concentration, but is confined to particular situations of limited extent. This will be rendered evident by the following examples. Dr. Trotter informs us, that the Assistance wooded and watered at the island of St. Thomas in 1762, and, with a view to expedition, a tent was erected on shore, in which the people employed on these services lodged during the night. On the middle passage, *every man who had slept on shore died;* while the rest of the ship's company remained remarkably healthy."*

This, however, is not all. We also know that the agent thus diffused in the air is extricated from the surface of the earth, or the soil of those localities in which it is found. In the first place, it has been ascertained that the circumstances which favour the extrication of other gaseous matter from the surface—such as

tween the sea and the land during the day and the night. The former, which blows from the sea to the land, sets in early in the morning. The latter, which takes the opposite course, commences soon after sunset.

* Medicina Nautica, Vol i., p. 456.

aqueous vapour and the products of decomposing matter in the soil—also promote the accumulation of this morbid agent in the air. Hence it is that malaria is always present to a greater extent in intertropical regions than in temperate ones, and in the hot seasons of all climates, rather than during winter. Again, the cutting down of forests, and particularly in warm climates, is always found to be attended by serious results to the surrounding inhabitants; for the surface of the soil, which was protected, to a greater or less extent, from the rays of the sun, becoming exposed, exhalations will arise to a much greater extent than before. This has been constantly observed in the East and West Indies, and more particularly in America; the intermittents and mild remittents of Pennsylvania, for example, as we are informed by Rush, being converted, after clearing the soil, into severe and malignant forms of remittent fever. We are also told by Macculloch, that the district of Bresse (Lyonnais), which was comparatively healthy when full of woods, has become nearly depopulated since they were cut down.* For the same reason, opening the ground with the spade, or the plough, for the first time, is almost invariably attended with serious and fatal results in warm climates. This fact is well known in the West Indies and in America.† On the other hand, *continued cultivation*, by favouring the extrication of the matter, and preventing its accumulation and concentration, will render an unhealthy district more healthy than before.

* On Malaria.

† Cassan states, that the breaking up of pasture lands, in the West Indies, has sometimes produced fevers that resembled an absolute plague—the labourers even dying on the spot, if they attempted to remain at night on the ground they had broken up in the day.—*Mémoires de la Societé Médicale d'Emulation.* Ann. 5, p. 56.

Not only do we know the source whence the poison is derived, but we are so well acquainted with the circumstances that favour or retard the extrication of the morbid matter from the surface, that they have been set down as laws—an enumeration and consideration of which will be useful and interesting on the present occasion.

Law 1.—The malarious poison, although not confined to such situations, is extricated in greatest abundance in low, marshy, and alluvial soils.

Thus, if an inhabitant of the hilly or mountainous districts, in a malarious country such as Italy, descends into the plains below, he will, at certain seasons of the year, be attacked with intermittent fever—a disease unknown on the heights above. If, however, instead of a temperate region, he resides in an intertropical one, he will, under the same circumstances, be immediately attacked with the severe form of remittent, or continued fever. For instance, the barracks at Antigua are situated on a range of high hills—700 or 800 feet high—that surround the harbour. "During the occupation of this island by white troops, it was no uncommon thing," observes Dr. Ferguson, "for a seasoned soldier, who had descended to take guard at the dock-yard, surrounded by marshes, to be attacked with furious delirium, *while on post*, and to expire in twenty hours, with all the horrors of black vomit. But no cases of fever were observed among the officers or men whose duties confined them to the heights above."* As the operation of this law

* As I shall have occasion to refer to this author frequently, it may be as well to state, in order to save repetitions, that the quotations are taken from two papers—one on "Yellow Fever," inserted in the "Medico-Chirurgical Transactions," vol. viii.; and the other on "The Nature and History of Marsh Poison," contained in the "Transactions of the Royal Society of Edinburgh," vol. ix.—When an inhabitant of the

will be rendered more apparent as we proceed, it is unnecessary to dwell longer on this point now; we may, therefore, pass on to a consideration of the next law.

Law 2.—Malaria is extricated from all wet lands, the muddy surface of marshes, and the slimy banks of lakes and rivers during what has been termed *the drying process.*

Abundant evidence exists in the works of modern writers on Malaria of the operation of this particular law; but the point has been dwelt upon more particularly by the late Dr. Ferguson, who had great opportunities of studying the influence of malaria in different climates, and who, at the same time, profited by the opportunities he enjoyed. "In the West Indies," remarks this author, "the swamp is often exposed to the continued operation of a tropical sun, and its approach to dryness is the harbinger of disease and death to the inhabitants of the vicinity." Montfalcon also remarks, that "the air of malarious districts is not prejudicial to health, excepting after the retreat, or the evaporation, of the waters of the marsh, or the lake (*étang*), when the mud becomes exposed to the rays of the sun." * For the same reason, in Africa and nearly all intertropical climates, the most unhealthy period is immediately after the rainy season; while it was on the retiring of the waters, after the rains and inundations, that the great mortality commenced among our troops at Rangoon. We can thus understand why, in a wet, half-flooded country like Holland, the inhabitants should state, that the most sickly years are

interior of Mexico—which is elevated and mountainous—descends to the alluvial and low lands of Vera Cruz, he runs the same risk of being attacked with yellow fever as the European recently arrived.

* Traité des Marais.

converted into lagoons, and become comparatively innocuous for the time. Were it not for this circumstance, many parts of the island, as some already are, would be uninhabitable; for, whenever there is a cessation of the ordinary rains, disease is sure to occur in an aggravated form.

It must therefore be apparent, that the elements productive of disease are *never* given off from the surface of water under any circumstances whatever; and yet we daily observe opinions and conclusions enunciated, by medical writers, in direct opposition to this well established law. Thus various writers have referred the production of disease to gaseous matter given off from the surface of the Thames during the increased temperature of summer—a point which has been particularly dwelt on by Mr. Glaisher of the Observatory, Greenwich. Dr. Sutherland, also, in enumerating the various predisposing causes of cholera, assigns, as one of them, "Unwholesome vapours exhaled from the Thames, in consequence of the water being polluted by the sewage of the metropolis." * It must be evident, not only from the facts now detailed, but also from a consideration of the previous law, that the morbid effects witnessed in these instances are due, not to the exhalations that arise from the surface of the water, but to those extricated from the muddy bank of the river.

Law 4.—Malaria becomes innocuous at a certain distance from the source whence it is given out.

Monfalcon and other authors have defined the limits of the operation of this poison to be 500 or 600 yards in a perpendicular direction, and 300, or 400 in a horizontal one; but it will vary according to circumstances, the temperature at the moment, the prevalence of particular winds, the presence of hills, mountains, &c.

* Report of General Board of Health, 1849.

It is well known in intertropical climates, that if ships anchor near enough to smell the land breeze, the health of the crew will be affected; but by keeping beyond, no ill effect is experienced. Sir G. Beane tells us that the ships in the roads at Flushing were entirely free from the endemic that was committing such ravages among the troops: and Sir J. Pringle states that Commodore Mitchell's squadron, which lay at this time at anchor between South Beveland and the Island of Walcheren, in both which places the distemper raged, was neither affected with fever nor the flux.* The width of the channel in the former instance is 6,000 feet. If we take the half—3,000 feet, or 1,000 yards—we shall have the distance at which the poison became innocuous in this instance. Dr. James Lind also informs us that "in 1750 the Prince ship of war anchored in the Bay of Aristane (in Sardinia), where twenty-seven of the men sent on shore on duty were seized with fever: twelve were taken on board delirious, and seven died. In the ship which lay only two miles distant from the land none were taken ill." † This author states, however, that in the West Indies the malarious poison has been carried *three* miles out to sea; but this is an exceptional case, although other examples of the same kind are not wanting. Thus the exhalations from the Lake Aquano in Italy reach as far as the Convent of Camaldoli, which is situated on a high hill three miles distant. It also appears by the valuable Statistical Tables of Sicily, by Captain Smith, that of seventy-six unhealthy towns and villages, thirty-five are situated on hills or declivities—some of them at a considerable distance from the tracts whence the poison is known to be given out. This,

* Loc. cit.

† Essay on the Diseases of Hot Climates, p. 27.

however, only occurs with those towns exposed to the influence of the southerly winds; for in Italy the southern winds are found to carry the malaria farther than the northern ones. This may be ascribed, in part, to the fact that they blow over more pestiferous districts; but principally to their higher temperature, which will enable the heavy malarious gas to ascend to higher elevations than under ordinary circumstances. We may therefore conclude that, after a certain height, all situations are free from endemic fever; not only in temperate climes, but in intertropical ones also,—although the line of *perpetual health*, or freedom from endemic disease, will necessarily be higher in the latter situation than in the former.

Law 5.—The specific gravity of malaria is greater than that of atmospheric air.

The consideration of this particular law is of some importance, both in a practical and scientific point of view; for it is only by a knowledge of the difference in the specific gravity of malaria and of atmospheric air, that we are enabled to understand a variety of phenomena that are observed in certain localities. It is well known in all malarious countries—such as Spain and Italy—that the most dangerous periods are immediately after sun rise and sun set. This phenomenon has been particularly dwelt upon by Laucise, who has devoted a chapter to its consideration.* The only way in which it can be accounted for is this. Malaria, like aqueous vapour and other gaseous matter, will be extricated in greater quantity immediately after sun rise; it must therefore exist in greater abundance in the lower strata of the atmosphere at this period than previously. Being aided, however, by the increase of temperature, it will be slowly elevated

* De nativis et adventitiis Romani cœli qualitatibus.

into the higher regions of the air, and is thus comparatively innocuous during the remaining portion of the day. When, however, the rays of the sun are withdrawn, and the temperature of the surrounding medium lowered, the poisonous elements, if of less specific gravity than atmospheric air, will necessarily descend and float on or near the surface of the earth—to be again elevated, on the succeeding day, by the same means. It is to this latter circumstance that we must ascribe the greater danger of inhaling the external air immediately after sunset; for we may infer that the malarian agent will subsequently become deposited on the surface, or at least a portion of it, and thus be productive of less injury than previously. Whether the poison be absorbed again by the soil is a question not so easily answered. That it is so to a certain extent we may readily infer; but much will depend on the soil, its absorbing properties, and the presence or absence of water, which, as will be hereafter shown, has no attraction for malaria. Much also will depend on temperature, for when this is greater, or when the differrence of temperature between the day and the night is less, the poison will not have the same tendency to the surface, and will float in the strata of the atmosphere immediately above. Hence it is more dangerous to inhale the night air, in intertropical climates, than that immediately after sunrise or sunset. In many of the pestiferous spots between the tropics, as at Batavia, it is death for a European, newly arrived, to sleep on shore for a single night, although he may pass the day in the same spot with comparative impunity. But the night air is always more injurious in all malarious countries—even in temperate ones—and it is for this reason that it is dangerous for a stranger to traverse the Campagna of Rome at night, although the same tract may be passed

in the day with impunity. We may therefore infer that malaria exists in greater quantity in the lower strata of the atmosphere during the night than during the day, and that this is due to its greater specific gravity.

For the same reason, the effects of malaria are found to decrease with the increase of altitude from the surface. Not only in intertropical climates will continued fever be found on the plains below, remittents on the heights immediately above, and intermittents at an elevation somewhat greater, but it has been found that the difference of a few feet will cause a variation in the ratio of cases, or the chances of an attack. In the barracks at Spanish Town, Jamaica, which consisted of two stories, three cases of fever, as we are informed by Dr. Jackson, occurred on the lower story to one on the upper; and the same result has been remarked in almost all situations in intertropical climates. In the West Indies it has been found, as a rule, that two-thirds more men are attacked on the ground-floor than on the upper.

As a consequence of this peculiar property, the poison is found to creep along the surface of the earth, and to gravitate into ravines, fissures, and holes—particularly when aided by certain winds. Hence it is that the former situation is often found to be more dangerous than any other in malarious districts. Dr. Ferguson tells us that, at Fort Matilda, in Basseterre, Guadaloupe, a well-built store-room and guard-house, placed at the confluence of two dry and rocky ditches, was utterly uninhabitable. "The best seasoned of our artillerymen were sure to be seized with fever if they slept there a single night." For the same reason, malaria is often found in a state of greater concentration in valleys than on plains, as has generally been remarked in Italy, Greece, and other countries. Valleys, however, not only confine, but they

also conduct the poison in particular directions—so that, when the sea-breeze or other wind blows across the swamp, the malarious agent is carried for some miles inland.

Law 6.—The interposition of a forest, a mountain, a wall, or even a mere cloth, is sometimes sufficient to preserve an individual, or individuals, from the pernicious effects of the miasmata given out on the opposite side.

This is a very interesting and important law, the knowledge of which will be found of great practical utility. The protecting influence of trees was so well-known to the Romans, that they planted groves in all the exposed situations, even on the top of the Capitol, and other elevated places; and it was for this reason, probably, that certain groves were rendered sacred by them.* The moderns, however, in contempt of their sacred character, and in ignorance, apparently, of their value, have cut down the trees, and rendered certain situations, before habitable, if not healthy, dangerous or uninhabitable. Formerly, there was a large forest to the south of Rome, and which extended from Frascati and Albano as far as the Tiber, and protected that part of the town from the emanations of the Pontine marshes and adjacent plain. "The axe," says Lancisi, "destroyed this valuable barrier, and the Campagna of Rome became uninhabitable." Trees, however, will act, not only as a screen between a town and a pestiferous tract, but also by preventing the extrication of the poison from the surface beneath, as was before remarked.

The beneficial influence of high walls in warm climates and in malarious countries has been known from the

* Livy states that in the forest on the Vatican Hill an ancient evergreen oak was found, with an inscription in Etruscan characters, stating that it (or, rather, the grove itself) was sacred.

remotest period, as we may learn from Tacitus. In his remarks on the rebuilding of Rome, he states that high houses and narrow streets tend to preserve the health. That narrow streets and high houses are beneficial in all warm and malarious countries is an axiom that has been confirmed by the experience of ages; and hence we find this arrangement adopted in all the southern parts of Europe and other warm climates, as in China. At Canton, with the exception of two or three in that part inhabited by the Europeans, the streets are so narrow that there is not width enough for a carriage to pass. Their beneficial influence may be explained in two ways: they act as screens to the exhalations from without, and they also arrest the rays of the sun, and thus prevent exhalations from the surface within the town.

In other situations, again, as in isolated houses, and on board ship, the intervention of a wall, a cloth, or even a mere blind, has been sufficient to preserve individuals from the malign influence of the cause that has been detrimental to others. Having visited many of the pestiferous spots of intertropical climates, I have preserved myself, on more than one occasion, from an attack of the prevalent disease, by the simple precaution of putting up a blind, or closing the window of my bedroom at night—an act, however, that requires some amount of moral courage in a warm climate, and under a tropical sun.

Having thus narrated the circumstances and defined the laws which regulate the extrication of malaria from the surface, and its diffusion in the surrounding air, we may now pass to a consideration of the properties and effects of this invisible agent.*

* The preceding laws are nearly the same as those laid down by Dr. Aiton (Dissertation on Malaria) and other writers, and very

PROPERTIES OF MALARIA.—As the poison has never been collected or separated from the medium in which it exists, we are unacquainted with its chemical properties or composition, while we are only able to ascertain its other properties indirectly and by analogy. We may, however, conclude, as the result of the preceding facts, that it is a gaseous compound, although some doubts have been thrown on the subject. Dr. James Johnson, in his work on the Diseases of Tropical Climates, remarks:—"From observing the effects of miasmata, and the obstacles capable of arresting their course, an observer will not be able to repress some rational doubts on the justice of the opinion which pronounces bad air to be a substance similar to our known permanent gases; for it will appear absolutely impossible to him that a gas could have been thus stopped, sifted, strained, and deposited." If, however, malaria be, as has been already concluded, specifically heavier than atmospheric air, all the above circumstances admit of a ready explanation, for nearly the same phenomena are observed with carbonic acid gas. We must also infer that it is a compound substance, for it can be decomposed and rendered innocuous, a result that will be more particularly demonstrated hereafter.

similar to the inferences of M. Regaud de Lisle. (Mémoire sur les Proprietés Physiques du Mauvais Air.—Bibliothèque Universelle, Mai, 1817.) It is a cause of great regret to me that, for the reasons previously mentioned—the want of access to the English and foreign works on the subject of malaria—I have been obliged to depend on the notes I had by me in support of the opinions and conclusions advanced on this subject. To have supported my opinions with more copious references to other writers would not only have been more satisfactory to my readers, but it would also have been rendering an act of justice to those who have preceded me in the same path, and who have laboured so well and so diligently in the same field—of pestilence and of death.

There is another property of malaria that we are acquainted with, and which is a very important one in a practical point of view: that it possesses *no odour* by which it can be distinguished. Although usually emitted with odorous substances, it will be easy to show that the one is not a necessary accompaniment of the other. Thus, the town of Point au Petre, at Guadaloupe, is situated among the most offensive marshes in the world, yet it is, as we are informed by Dr. Ferguson, far from being unhealthy. "The same," he adds, "may be said of Port Louis—the first outpost—where the waters are so stagnant and putrid, that it is even more offensive than Point au Petre. But at Fort Fleur d'Epée—the farthest outpost at the extremity of the marshes—where *no smell exists*, there cannot be conceived a more deadly quarter; and all white troops, during the occupation of that island by the English, considered their being sent there equivalent to a sentence of death." Take another example. The town at Green Island, Jamaica, is situated close to an extensive swamp, and it was prophesied that, if the epidemic cholera broke out there, the inhabitants would die off like rotten sheep. Some cases having occurred, I was requested by the authorities to proceed there, and took up my abode in a house on the margin of the marsh, the stench from which was so powerful, that I was obliged to close the window of my bedroom at night. To the surprise of everybody, there were only thirty-three attacks and five deaths, the latter occurring previously to my arrival. Of the remaining twenty-eight attended by me, *all* recovered, so that I obtained the most favourable result as regards the treatment of the disease in Jamaica in this pestiferous spot. But, what is still more singular, there was no fever in the town of Green Island, although it was prevailing to a considerable extent, and epide-

mically, on the neighbouring hilly districts, and in the healthy parish of Hanover. It was also in these very districts, on dry, calcareous hills, where the decomposition of organic matter went on to the smallest possible extent, that the ravages of the epidemic cholera were the greatest —fifty, sixty, and seventy per cent. of the population in the small villages and hamlets having been cut off. Look, again, at the Campagna of Rome, where, from the absence of marshes and organic matter, the putrefactive process cannot go on to any extent, and where no offensive or perceptible odours exist; and yet there is no spot in Europe where malaria is to be found more constantly, or in a greater state of concentration. The same may be said of the environs of Madrid and other places, but, as it will be necessary to refer to these examples hereafter, while discussing the probable origin of malaria, it is unnecessary to adduce further proof of the truth of the above conclusion. It is only requisite to bear the important fact in mind, in order not to commit those errors which are made every day by certain writers, who appear to be entirely ignorant of this peculiar property of malaria.

Another property of malaria is, that it is not absorbed by water, excepting in the smallest possible quantity. This inference is directly opposed to that drawn by other writers; for it is usually stated that malaria is lost and absorbed by passing over a small body of water. My reasons for not concurring in the truth of this conclusion are the following.

It has been already stated, that this poison is never given off from the surface of water, under any circumstances, or conditions whatever; but this is incompatible with the supposition of its absorption by this fluid. Water can only absorb a given quantity of any substance,

gaseous, or other; while, as regards the former, the excess is extricated as soon as it arrives at the point of saturation. This occurs with all gases, the same with those that have the greatest attraction for water, as with those that have the least; the effect being hastened by an increase of temperature, so that the whole of the gas will generally be expelled when the water arrives at the boiling point. But we observe no such results with malaria, for this substance is not extricated from small bodies of water more than from large ones, a result not confined to temperate climates, but experienced in the hottest. If the most pestiferous marsh in the torrid zone be only covered with water *an inch deep,* the extrication of malaria will be as effectually prevented as if there were a dozen feet of water, or as many fathoms. This could not be the case, if the poison were absorbed by the water, for, when saturated, the excess would of course be evolved.

On the other hand, malaria is extricated from the margin of large lakes, and the banks of the largest rivers—both tidal and others—the same as from a small rivulet, or a stagnant pool. Let but the smallest portion of the margin, or the muddy surface of a lake, or a river, become exposed, and the poison will, if the temperature of the atmosphere be sufficiently high, become immediately evolved; no matter how great the body of water may be, with which it was previously in contact. But such an effect could not be witnessed, if the operation of Law 3 depended on the attraction of water for malaria, as the morbid agent in such a case, instead of remaining in the soil to be extricated into the air subsequently, would have become absorbed by the water, particularly when the lake or river was large, and when, as in temperate climates, the quantity of the poison evolved is not great. So, again, if the attraction of water for malaria was so great,

the neighbourhood of lakes and rivers ought to be the healthiest spots; but they are invariably the most unhealthy, the same with the largest lakes as with the smallest pond: with the impetuous Ganges, and the mighty Orinoco, the same as with the smallest rivulet, or the most minute and sluggish stream. Volney states, that every river in America which he visited, whether great or small, rapid or stagnant, produced malaria, and was equally unhealthy.

As to the apparent absorption of malaria by water, inferred by the generality of writers, the phenomenon admits of explanation in another way. We have seen that the specific gravity of this invisible agent is greater than that of atmospheric air, in consequence of which it has a tendency to float along the surface, and to gravitate into ravines, fissures, &c. As the level of the water in rivers is almost invariably below that of the adjacent soil, and sometimes very much below that level, the malaria diffused in the surrounding air would gravitate towards the water, and float on the surface. In such a situation, it might be carried some considerable distance, either by winds, by force of gravity, or by a sort of under current in the lower strata of the atmosphere, produced by the current of the river—an effect that would be greater in a non-tidal river than in a tidal river. Now, it is precisely in the former situation, that the phenomenon has been more particularly observed, for writers on malaria state, that the poison is rapidly and completely absorbed by passing over a stream of *running* water. If, however, that were the case, the beds of mountain torrents ought to be healthy spots; but they are generally most unhealthy, as has been before shown. We may therefore conclude that malaria is not absorbable by water, particularly as the explanation now offered will account for the phenomenon under dis-

cussion. It will also explain why the banks of rivers are invariably so unhealthy, even those where it seems difficult to account for the extrication of the poison. If the malarious tract be situated on one side of the stream, those living merely on the opposite side might remain exempt from its injurious operation, while those on the same side, and situated between the marsh and the river, would suffer to a greater extent than under ordinary cirumstances—placed as it were in the track of the morbid current. This would seem to be the only way in which we can account for the above facts, and, at the same time, reconcile the two anomalies—the apparent absorption of malaria by water, and the unhealthiness of the neighbourhood of all rivers and lakes.

Effects of Malaria.—We are unfortunately better acquainted with the effects of malaria than with its properties, and for a very sufficient reason,—from its deleterious action on the health of man. "The value of life," observes Dr. Macculloch, "of survivorship, the average chance of approaching to the proverbial limit of threescore years and ten, is the measure of the salubrity of a country; and that salubrity depends, mainly, on the presence or absence, the range or limitation, of malaria. How widely malaria is a cause of death will be apparent, almost on a moment's consideration, when we recollect that in all the warmer, and hence more populous, countries, nearly the entire mortality is the produce of fevers, and these fevers the produce of malaria." * But, as Dr. James Johnson has justly remarked, "A moment's consideration must show us that fever and ague, two of the most prominent features of the malarious influence, are as a drop of water in the ocean, when compared with the other less obtrusive but more dangerous maladies that silently, but

* Loc. cit.

effectually, disorganize the vital structures of the human fabric, under the operation of this deleterious and invisible poison. The jaundiced complexion, the tumid abdomen, the stunted growth, the stupid countenance, the shortened life, attest that habitual exposure to malaria saps the energy of every bodily and mental function, and drags its victim to an early grave." * Or, as the preceding writer expresses it, "to live a living death, to be cut off from more than half of even that life, to be placed in the midst of wealth and enjoyment, yet not to enjoy, such is the fate of man in the lands of Europe where malaria holds its chief seat: while, in the tropical regions, it is to fall by thousands and tens of thousands, the summer harvest of death walking hand-in-hand with that of the vegetable world." There is, perhaps, no nation that has had so many melancholy proofs of the latter result as our own; witness the expedition to Walcheren, the war in Spain, the operations of our fleets and armies in intertropical countries, and although last, not least, the expedition to the Crimea. In fact, we may say, with no less truth than sorrow, when we record the deeds of arms of our brave countrymen, if the sword has slain its thousands, malaria has slain its tens of thousands. One Scotch regiment, left in Holland, at Sluys, buried its *whole* number in three years; while Dr. Mosely asserts, that *none* of the Europeans, sent in 1780, in the expedition to St. Juan, retained their health above sixteen days, and not more than 300 ever returned. He also states that at the taking of Fort Cinoa from the Spaniards, "half the Europeans who landed, died in six weeks." † In addition to the above, it will be my object to show, hereafter, that the influence of malaria is even still greater, and that not only the endemics of intertropical and malarious countries, but those of all other,

* Philosophy of Travelling. † On Tropical Climates, p. 146.

and temperate climes, are also due to the operation of the same invisible agent.

There is one characteristic of malaria that requires to be mentioned, and this is that strangers, or those coming from another and more healthy locality, are sooner and more easily affected by the poison than those accustomed to inhale the infected atmosphere. Another, also, of some interest and importance is that the poison, when present in the atmosphere, favours the decomposition of organic matter, while it would appear to exert some influence on substances not liable to undergo decomposition under ordinary circumstances.* This effect on organic and inorganic substances has been observed in all malarious districts; and its absence or presence has been considered a good test of the healthiness or unhealthiness of the locality or the season.

Having thus attempted to point out the source whence the poison of malaria is derived, and having considered the circumstances which regulate its extrication from the surface, as well as its properties and effects, we may now proceed to inquire into the manner of its production. By the generality of writers, malaria is supposed to be a product of the decomposition of organic matter; by some, both of vegetable and animal substances; by others, of a mixture of the two, while a few conclude that it is due to the decomposition of animal matter alone. The influence of animal matter, in the production of malaria, has been recognised from the remotest periods: some ascribing the effects observed to the products of the decomposition of dead animal matter; others to the

* Substances fabricated of silk, wool, and even cotton and flax exposed to marsh exhalations, very rapidly undergo decay: silk and woollen substances becoming putrid, and cotton and linen assuming a dingy or yellow hue, and afterwards losing their cohesion.

introduction of minute and invisible insects, present in the air of those localities where endemics prevail. Livy and other authors, down to Lancisi, have advocated the latter opinion. The generality of modern writers, however, consider malaria to be the product of the decomposition of organic matter—vegetable and animal,—for in those localities where this poison is usually extricated, insectile life abounds, as well as vegetation. This opinion has been sustained by all modern Italian writers, from Lancisi (who advocates two theories, that just referred to, and the preceding one) down to Puccinatti; * by all the best French authors—including Alibert and Monfalcon—and by all English ones, from Cullen to Johnson.

This, as is apparent, is somewhat similar to the theory just discussed, and would, at first sight, appear almost the same. There are, however, some striking and important differences which will be discovered when the question is examined more narrowly. Independently of the facts before mentioned, that the advocates of the modern theory refer both epidemics and endemics to the same cause; as, also, that certain circumstances, not previously considered to be exciting causes of the latter class of diseases, are also included in the list of morbid agents by the latter theorists; there will also be found a considerable difference in the two theories, as regards the influence and operation of organic matter, and the manner in which the poisonous elements are produced. By these it is inferred, that organic matter of all kinds, vegetable and animal, the excretions of man, &c., as well as that found in all situations, in the soil, or on the surface in the towns, houses, &c., are productive of disease. By the older theorists, malaria is only supposed to be produced *in the soil*, and in certain situations,

* Storia delle febbri entermittenti perniciose di Roma. Pisa.

such as marshes, swamps and lagoons, alluvial tracts, as also the banks of rivers and lakes,—a great and striking difference. By the one, the uninhabited district is considered to be the most dangerous; by the other, the inhabited and populous town; so that the circumstances that have favoured the civilization and happiness of man, have thus become, according to this doctrine, the cause of disease and death. Man, therefore, must henceforth flee his fellow, not only during seasons of pestilence, but even at all other times. It is not necessary, however, to pursue this subject further: the great differences that exist between the two theories will be apparent to every one from what has been already advanced. We have now only to ascertain if malaria be produced by the decomposition of organic matter in the soil of those localities whence it is more commonly extricated.

It so happens that malaria, as is apparent from what has been already advanced, exists, to the greatest extent, precisely in those situations where organic matter is found in the greatest quantity: while there, also, where the products of putrefaction most abound—viz., in warm and intertropical climates,—disease prevails to the greatest extent, and in its greatest intensity. More than this, the only extraneous gases yet discovered in the air of malarious districts are those known to be products of putrefaction: hence malaria has been supposed to be carburetted hydrogen, sulphuretted hydrogen, or ammonia, but more particularly the two former. Volta was the first to collect and analyze the gas of marshes, which he pronounced to be inflammable air—the same as that given out by coal; an opinion since confirmed by Chevreuil, who states that it is composed of one volume of carbon and two of hydrogen (proto-carburetted hydrogen). Hence this gas has been termed, *par excellence, le*

*gaz des marais.** If, however, the arguments before used have any weight, we must infer that the effects under consideration are not produced, either by this or by any of the gaseous products of putrefaction. That malaria is not either of the known products of decomposition may be shown in another way; by an inquiry into their physical and chemical properties, and then comparing them with those possessed by this invisible agent. Setting aside the carbonic acid and the nitrogen,—which, for the reasons already stated, are not noxious gases, and cannot, therefore, be productive of morbid effects,—there will remain ammonia, phosphoretted hydrogen, carburetted hydrogen, and sulphuretted hydrogen.

Although one of the accused gases, it is clear that ammonia cannot be the unknown substance under consideration, for two reasons: its specific gravity is only half that of atmospheric air, while it possesses a strong and peculiar odour. Malaria, on the contrary, is without odour, while it is much heavier than atmospheric air. It is also soluble in water in the largest possible proportions;† but malaria, as I have attempted to show, is insoluble. As regards phosphoretted hydrogen, it must be at once rejected on account of its strong and fetid odour, for it is precisely to the presence of this gas and sulphuretted hydrogen that the strong smell arising from decomposing substances is due. Water, again, absorbs this gas, but in small quantity, so that

* Dictionnaire des Sciences naturelles, t. ii., p. 233.

† While 1,000 gallons of water only absorb 5 of oxygen, 25 of nitrogen, and 1,000 of carbonic acid, the same quantity will absorb 500,000 gallons of ammonia when in the form of gas. According to the generally received opinion, therefore, it would approach malaria, as regards this particular property, nearer than any of the other products of decomposition: according to my conclusions, it will be the farthest removed.

it is freely given out from the surface; but malaria is never extricated from water. It, however, possesses one of the properties of the latter substance, which is, that it is heavier than atmospheric air; its specific gravity being 1·185.

It is, however, to carburetted hydrogen that the morbid effects are more generally ascribed. But it has been already stated that this gas is non-deleterious: if so, it cannot be productive of the effects under consideration. Supposing it otherwise, however, it cannot be the morbid agent, malaria, for although without odour, it is specifically lighter than air (0·5590). Again: its attraction for water being slight, it is extricated in the greatest abundance from the surface of all waters, such as those of marshes, lakes, &c. It cannot, therefore, be the agent we are in search of.

It only remains to consider the last of the above gaseous substances—sulphuretted hydrogen. Although specifically heavier than air (1·1912), its peculiar and offensive odour would alone be sufficient proof of its not being the subtle poison which walketh abroad, even at noonday, unseen but not unfelt. In addition to this, it is only absorbed by water in a small proportion, for it is given out from the surface of all stagnant waters, which contain an abundance of organic matter, in such quantity, that for this reason it has been set down as the morbid agent itself—the satellite mistaken for its planet.

As the establishment of the preceding facts is of some importance, I have placed them together in the following table, which, although fanciful to a certain extent, will yet render the matter so clear that it can be understood at a glance.

TABLE 3.—Table showing the difference between certain properties of malaria, and the products of putrefaction.

Substances.	Inodorous.	Heavier than Air.	Insoluble in Water.	Number of Properties.
Malaria	Yes.	Yes.	Yes.	3
Ammonia	No.	No.	No.	0
Phosphoretted hydrogen .	No.	Yes.	No.	1
Carburetted hydrogen . .	Yes.	No.	No.	1
Sulphuretted hydrogen. .	No.	Yes.	No.	1

We may therefore say, with a certain august assembly, that the Noes have it. In fact, none of the accused gases possess more than one of the known properties of malaria. Even the remaining products, excluded for other reasons, do not possess all the properties of this poison. Carbonic acid comes the nearest, being inodorous and heavier than atmospheric air; but then, independently of the fact that it cannot be the bane and antidote at the same time, it does not possess the remaining property, being absorbable by water. As to nitrogen, the other product, it only possesses one of the above properties, being inodorous; but then it is lighter than atmospheric air, and soluble in water. We may therefore infer that malaria and the products of putrefaction are not the same, but different substances.

We might have arrived at this conclusion, however, in a more simple and summary way; and from the single fact that, while malaria is, as I have attempted to show, insoluble, all the products of putrefaction are soluble in

water. Or we may draw another comparison—one which does not admit of any dispute. It has been laid down as a law, that this invisible, but well-known gaseous substance, is never extricated from the surface of water, under any circumstances or known condition whatever. This simple fact, without any other, will at once enable us to affirm that neither of the gaseous products of putrefaction is the substance called malaria, for all these gases are given out freely and in large quantities from the surface of all waters—from flowing rivers the same as from lakes and other collections of stagnant water. How much, therefore, might this inquiry have been simplified and shortened by a reference to this single law; for all the arguments and facts that have been previously advanced to prove that malaria is not a product of putrefaction would thus have been rendered unnecessary. And yet there can be no doubt respecting the soundness of the inference that has been drawn on the subject; only the operation of this law is not universally acknowledged, nor, I may add, generally known. Such a knowledge would have saved a great deal of writing, and have prevented, at the same time, the enunciation of many false theories, erroneous doctrines, and illogical conclusions. For instance, not only carburetted hydrogen, but sulphuretted hydrogen, has been considered by certain writers to be the morbid agent productive of all the effects witnessed by the operation of malaria, merely because this gas is given out in great abundance from the waters of marshes, lakes, &c.—the very reason why it cannot be this particular substance. A similar error has been lately committed by Dr. Letheby, the Health Officer of the City of London, in his last Report. He observes:—"The river is unusually charged with sea-salt and organic matter. The sewage, and the organic matter, and sulphates of the sea-water

have acted on each other, and have produced the state of things with which, for the last fortnight, we have been so familiar. The inky appearance of the river has been caused by the fixation of the sulphuretted hydrogen by the iron of the clay. This has been *the salvation of our lives*, for, offensive as has been the vapour evolved from the river, it is as nothing in comparison with what it would have been if the much-abused clay from the lower shores of the river had not fixed the *miasm* in a solid involatile form." I do not know whether the writer, in common with the late Mr. Daniel and others, considers this gas and malaria to be one and the same substance, or whether he concludes that sulphuretted hydrogen is injurious, *per se*, as one of the products of putrefaction. In either case, however, the conclusion is equally erroneous. The facts just stated prove that it cannot be the invisible agent termed malaria; while those previously adduced, when considering the properties of the products of putrefaction, demonstrate that it can never cause any general disease, either epidemic or endemic. Such errors as these are the more to be regretted when they come from persons placed in authority, and who, as the guardians of the public health, ought to be the first to dispel, rather than create, unnecessary alarm. True, Dr. Letheby states that the antidote and the bane were placed side by side in this instance; but, then, this gas is constantly generated in other situations, where no iron is present to neutralize and render it inoperative; its extrication, therefore, into the surrounding air would, if such an opinion were entertained, naturally create alarm and terror among those exposed to its influence.

We must therefore infer, as the consequence of these, as well as the preceding, facts, that malaria is not either of the products of putrefaction; at least, it cannot be one of

the known and ordinary products of putrefaction, when that process takes place on the surface.

It may, however, be argued that, when decomposition takes place beneath the surface, or in the soil, that some new element or compound is produced, not met with under ordinary circumstances. In order, therefore, to solve this important point, it is necessary to inquire if malaria is only to be met with in those situations where organic matter exists; for, if it can be shown that the poison is sometimes extricated in situations where the products of putrefaction are not to be found, the inference will be at once rendered invalid.

Having, many years since, devoted some time to an investigation of the intermittents of Spain, I was certainly surprised to find that this disease, which is the principal endemic of that country, was nearly as prevalent in many of the elevated and hilly districts as in the low and alluvial plains. Thus agues, as was previously remarked, are not only to be met with at Madrid, but they present the same type and intensity as in the rich and fertile plain of Valencia, although the quantity of organic matter, which exists in the former situation, is utterly insignificant when compared with the latter. The same facts were remarked during the occupation of that country by the British troops, and have been recorded by Dr. Ferguson. "In June, 1809," observes this writer, "the English army advanced towards Spain, marching through a singularly dry, rocky country, of considerable elevation, on the confines of Portugal. The weather had been so hot for several weeks as to dry up the mountain streams, and in some of the hilly ravines, that had lately been watercourses, several of the regiments took up their bivouac for the sake of being near the stagnant ponds of water (which, however, was perfectly *pure*) that were still left

amongst the rocks. Several of the men were seized with violent remittent fever, before they could move from the bivouac the following morning, and that type of fever, the first that had been seen on the march, continued to affect that portion of the troops exclusively for a considerable time. Till then, it had always been believed amongst us that vegetable putrefaction was essential to the production of pestiferous miasmata; but, in the instance of the half-dried ravine before us, from the stony bed of which (as soil never could lie for the torrents) the very existence even of vegetation was impossible, it proved as pestiferous as the bed of a fen." So also Monfalcon, while referring to certain marshy and alluvial districts of France, observes that the decomposition of organic matter—both vegetable and animal—must go on there to a considerable extent. "But," he adds, "there are, in other parts of France, large inland collections of water (*étangs*), in which accumulations of such matter are not found, and in which the water is clear and limpid; and yet the inhabitants suffer from fever equally in the one situation as in the other. They are equally rebellious, equally malignant in those parts of La Bresse where the lakes, or *étangs*, are situated, as where only marshes are found."* There are other facts still more striking. The soil at Walcheren, which has invariably proved so pestiferous to strangers, contains little or no organic matter, being sandy, or rather a mixture of clay and sand. Dr. Ferguson, also, speaking of the leeward shore of Guadaloupe, says that "the soil, for the distance of thirty miles, is a remarkably open, dry, and pure one, being mostly *sand and gravel*, altogether and positively without marsh in the most dangerous places; yet, it is inconceivably pestiferous throughout the whole t[illegible] no spot more so

* Histo[illegible]

than *the bare sandy beach* near high-water mark." So, again, while speaking of the innocuousness of certain collections of water at Lisbon, although in a state of great putridity and foulness, the same writer adds: "The most ignorant native is well aware, that were he only to cross the river, and sleep on the *sandy* shores of the Alentejo, where a particle of water, at that season, had not been for months, and where water being absorbed into the sand, as soon as it fell was never known to be putrid, he would run the greatest risk of being seized with remittent fever." In the Campagna of Rome also—a term almost synonymous with desert—malaria prevails to as great an extent, and in the same intensity, as in the immediate vicinity of the Pontine marshes.* As the Campagna is composed of volcanic rocks, alternated with beds of sand and scoriæ—called *pozzolana*—organic matter cannot exist in the subsoil more than on the surface. It is impossible, therefore, to refer the production of malaria, in this situation, to the products of putrefaction. Rome, also, rests on the same formation; the lower part of the town being built on the recent beds of Tufa—or pozzolana—and the more elevated on the ancient Tufa—or volcanic rocks,—of which the seven celebrated hills of Rome are composed. † There is a small alluvial tract

* To those unacquainted with the locality, it is necessary to remark that the Pontine Marshes are 30 miles distant from Rome: they can exercise no influence, therefore, in the production of fevers in the city, and in its immediate neighbourhood.

† It is this peculiar geological formation to which we must refer the origin of the catacombs. As this pozzolana is employed and mixed with lime as a cement,—and it is a most valuable one,—the beds which contain it, have been excavated, not from above down, but by means of galleries, in order not to disturb the surface. As these beds are not very extensive, or wide, being bounded by the ridges of the subjacent rocks, they have been worked out in different directions,

to the north of Rome, and another to the south, or south-west, but they are too far distant and too limited in extent, to produce any effect on all that portion of the Campagna lying to the east of the city.

On the other hand, there are many localities, abounding in vegetable and animal matter, where the putrefactive process is going on to a great extent, but which are entirely free from the effects of malaria. At Singapore, in the Straits of Malacca, there is a series of saline and fresh-water marshes, with an immense quantity of decayed and decaying matter—vegetable and animal,—yet fevers are never observed there. "There is," says Macculloch, "one mystery, for which I can conjecture no solution. It is a collection of jungles and woods, and marshes, and rivers, and sea-swamps; and it is a flat land, under a tropical sun, and it is a land of monsoons, and yet it is a land where fevers are unknown, and this land is our new settlement of Singapore."* It has also been stated by Dr. Wilson, in his statistical Report on the Navy, that the vast continent of South America, enjoys an almost perfect immunity from fever; although a considerable part of it is situated within the tropics, and notwithstanding that marshes, lagoons, and organic matter—prolific sources, as is supposed, of disease in other situations—abound. I have also had occasion to refer to the exemption of this

and to a considerable distance, so that these galleries extend nearly all round Rome, while some penetrate into the heart of the city. It was these subterranean galleries, formed of *pozzolana*, or sand and scoriæ, above and below, and, in general, of the solid rocks of tufa on either side, that served as places of refuge and of worship to the primitive Christians. It is the same formation, which has rendered the ancient buildings in Rome—composed of the solid tufa, or ancient submarine rocks, and cemented together by the almost as hard pozzolana—so imperishable.

* Loc. cit. p. 138.

part of the world—as, at least, that portion of the continent on either side of the great chain of the Andes—from epidemic.* There is another circumstance that should be borne in mind: this is the fact that the prevalence of disease bears no invariable relation to the amount of decomposition that takes place. In some years, when the process goes on to a greater extent than usual, there is little or no disease: in others, when the decomposition is much less, disease will prevail to a greater extent than usual. This has been noticed by Dr. Ferguson, who, while referring to the West Indies, remarks: "It is certain that, for years together, these supposed *fomites* of fever are comparatively harmless: and that, at other times, new comers suffer the worst attacks, in places where it is difficult even to imagine the existence of anything like marsh miasmata."

Another fact militates against the conclusion that malaria is a product of putrefaction: this is that agues, which are universally allowed to be the effect of the operation of this poison, are sometimes observed in seasons when the process of putrefaction cannot go on, or only to a very limited extent. Independently of Rome and its environs, where epidemic visitations of ague have been experienced in the middle of winter and in seasons of unusual cold, the same phenomenon has been experienced in other countries, and in the north of Europe. In Spain agues were epidemic the *winter* after the appearance of Asiatic cholera; and Alibert also speaks of a visitation at Grenoble, in the midst of snow, and with an unusual degree of cold. Agues, also, reigned at Berlin in the winter of 1698, according to Sydenham, and again, *without any interruption*, from 1702 to 1705. Van Swieten also states, that he has witnessed visitations of

* Remote Cause. Part ii. p. 9.

ague at Leyden in the middle of winter: while Frank observes that putrid exhalations are not necessary for the production of ague, for this disease has sometimes appeared at Wilna, with the thermometer 20 *degrees below zero.*

With such facts as these before us, it seems hardly possible to avoid drawing the same conclusion as Dr. Ferguson, viz.: "that putrefaction under any sensible, or discoverable form, is not essential to the production of pestiferous miasmata. It is in truth unnecessary," as this writer adds, "to multiply facts and illustrations of the same kind to prove that putrefaction and the matter of disease are altogether distinct and independent elements; that the one travels beyond the other, without producing the smallest bad effect; and that, however frequently they may be found in company, they have *no necessary connection.*"

M. Baily, also, who passed some time in studying the intermittents of Rome, came to the conclusion that the exhalations from animal and vegetable matter were not necessary for the production of these fevers. *

But then the question arises, how is this invisible agent produced? If not from a cause existing on the surface, or in the soil from which it is extricated, whence can the poison be derived, and how can it be generated? It cannot be due to any cause existing in the atmosphere, being first generated in that medium, and then deposited on the surface of the earth; for the effects would then be more general, instead of being confined, as is now the case, to particular situations of defined and limited extent. Besides, there are other facts which prove that malaria cannot be generated in the atmosphere; but it is not necessary

* Traité Anatomique Pathologique des Fièvres Intermettantes. Paris.

to adduce more than one: this is, that when the surface of an unhealthy district is covered with some impermeable substance, or with water, the diseases that previously prevailed will cease, and the supervention of others be prevented. The process, therefore, which produces malaria, must take place beneath, not above, the surface. Now, there is only one process that takes place beneath the surface, and which gives rise to the production of poisonous elements, independently of the decomposition of organic matter; and that process is what has been termed volcanic action. If there be no other way in which we can account for the generation of the poison, it is reasonable to inquire, whether it is not to be ascribed to this particular process? This is a question that I have already answered in the affirmative, as regards epidemic diseases, and I am induced to draw the same conclusion as regards endemics. It is not my intention, however, to enter into any arguments in proof of this conclusion, on the present occasion; not only because the subject requires a separate consideration, but also, because my object now is to point out what is the immediate, not the remote, cause of disease. The latter may be interesting in a scientific, but it is the former which is alone necessary in a practical, point of view. All that we require for practical purposes is to know the nature of the elements productive of disease, their situation, and the source whence they are derived. What the process is which gives them origin, and what the depth at which it takes place, are immaterial at the present moment. I may, however, be allowed to remark, it is only the hypothesis now referred to that will enable us to explain all the various anomalies which are left by the preceding theories; while all, or nearly all, the facts connected with the appearance and prevalence of epidemic and endemic diseases admit of explanation by a reference

to this theory. Several facts connected with this part of the subject will be alluded to hereafter; I will therefore only mention one, which admits of explanation in no other way. This is, that those living in cellars suffer more from fever than any other class—a fact clearly established by Dr. Duncan, in his interesting Essay on the prevalence of Fever in Liverpool. It appears, from the statistical facts adduced by this writer, that out of every 100 dispensary cases of fever, in that town, 36·22 were living in cellars: compared with the whole population, the cellar population yielded 35 per cent. more cases of fever. *

As regards certain objections that have been made to this theory, and which will no doubt be repeated, viz. that disease does not prevail to a greater extent in the neighbourhood of volcanos than elsewhere; and that epidemics prevail in situations where neither volcanos nor earthquakes are observed; I have only to add, that these objections have been already answered in the second part of my work on the Cause of Epidemics. These critics have not only mistaken my conclusions, but they have also confounded volcanic *action* with volcanic effects. I have never referred epidemic diseases to the eruption of volcanos, or, to the occurrence of earthquakes,—but to the *cause* which produces them. These phenomena are only particular effects of a particular cause; while it is to be remembered that they only occur at long intervals and uncertain periods; but the cause which gives rise to them,

* On the Physical causes of the high rate of mortality in Liverpool.

As to the ordinary causes assigned for the occurrence of disease, in such situations, it has been shown, in the preceding part of this chapter, that those living under ground in the Arctic regions, where the same causes are in operation to a much greater extent, are entirely free from fever. The only difference is, that, in the latter situation, the extrication of gaseous matter from the surface, or from the interior to the exterior, is rendered impossible.

tropical regions of the East, or the West, in the Savannahs of America, the Campagna of Rome, or the fens of Lincolnshire. Remittent and continued fever are, also, as generally referred to the operation of the same cause; for their connexion, as must be evident from the remarks previously made, is so close and so apparent, that no other conclusion can be drawn on the subject. This granted, the inquiry will be a very easy and a very short one. It has been already stated that agues were formerly as prevalent and as fatal in London, if not more so, than they now are in Rome. We are told by Dr. Caius, that the mortality from agues in London, in the year 1558, was such that, to use his expression, the living could hardly bury the dead. Bishop Burnet also states, that, at the time of the Reformation, they raged like a plague; while Sydenham considered them as one of the epidemics of London. Although epidemic in 1751, 1753, and 1754, they have gradually declined since that period, until the appearance of the epidemic cholera, since which they have again become more prevalent. According to Sir Gilbert Blane, the number of deaths under this head, for the first ten years of the present century, was only 4; but, according to the Registrar-General's Reports, there were 232 deaths in London, from this disease, from 1840 to 1850—an increase of 228 for the same number of years. This shows that ague is more common, at present, than is generally supposed; for this complaint is not usually fatal, excepting when complicated with other affections, or when assuming a malignant character. At the time when agues were thus common, continued and remittent fevers were equally prevalent, while the same order of succession that is now observed in malarious and, more particularly, intertropical climates, took place then—agues prevailing in the cold season, or winter and

spring, and the remittent and continued fevers in the summer and autumn. Although the connexion of these different forms of fever was not then properly understood, Sydenham, that acute observer, referred them all to one and the same cause. Like ague, the other two forms of disease have become less and less prevalent up to the present time—a result we should have expected to find, if they be all due to the same cause. They are, however, to be met with, and to a sufficient extent, to show that, if ague were not observed, the cause productive of this form of fever, as well as the others, is still in operation in London.

As regards the disappearance of these diseases, an explanation will be offered in the next Part; it is only now necessary to remark that they have been replaced, of late years, by another form of fever, viz., Typhus. This disease, which has prevailed principally since the appearance of the epidemic cholera, must not only be regarded, like the latter, as an epidemic, but it may also be referred to the same cause. As, also, I have before concluded, that epidemics are the effect of volcanic action, and as I have now inferred that endemics are due to the same cause, it follows that all the diseases observed in London, or elsewhere, are produced by one and the self-same cause—volcanic action. More than this,—it has been my object to prove, on the present occasion, that malaria s not a product of putrefaction, but of this particular process; and that it is generated, not on the surface, as in the soil, but in the interior of the globe—in an inaccessible and hidden laboratory.

It follows, therefore, if these deductions be allowed, that the cause productive of endemics is the same in all climates and in all situations, and that this cause is the operation of the poison termed Malaria. We must also

infer that this agent is extricated from the interior to the exterior of the earth, at particular times and under particular circumstances; and that the morbid effects produced in man are due to its diffusion in the air, and its inspiration into the system by the lungs. This is all that is necessary to be known, before entering into a consideration of the measures about to be proposed for the prevention of the disease; and which will form the subject of the next Part.

PART II.

ACCORDING to the advocates of what I have termed the organic theory, nothing can be easier than to prevent the return of epidemic and endemic diseases in future. "I would express my conviction," observes Dr. Southwood Smith, "derived from much observation and some experience, that the most distressing of the evils of which we have been speaking (the prevalence of disease) are capable of being almost wholly prevented in future." * As to the measures employed to accomplish this desirable result, they may be understood by a reference to the doctrines of these writers already discussed. But as no distinct treatise exists on the subject, and as both the doctrines and the practice of these sanitary reformers are only to be gleaned by searching a variety of Reports, written during the last twelve or fifteen years, it will be as well to define them more particularly. Dr. S. Smith states:—"In every district in which fever returns frequently and prevails extensively, there is uniformly bad sewage, a bad supply of water, a bad supply of scavengers, and a consequent accumulation of filth." And Mr. Grainger adds:—"It is, then, in filth: that is, in decomposing organic matter, that the main predisposing causes of epidemic diseases are to be sought

* First Report of the General Board of Health.

out—filthy alleys, filthy houses, filthy air, filthy water, and filthy persons."* These conclusions are confirmed by Mr. Simon, who sums up the whole matter in the following concise and simple aphorism:—"For the permanent avoidance of epidemic diseases, *cleanliness is the sole safeguard.*"† The removal of filth, therefore, would seem to be the only measure required for the prevention of endemic and epidemic diseases. And has it, then come to this, that the practice of medicine, after existing as a science for upwards of 2,000 years, should, in the middle of the nineteenth century, be handed over to the scavenger and the washerwoman? The College of Physicians may henceforth close its portals, or hand over the establishment to the incorporated Society of scavengers for the city and liberties of Westminster. As to the College of Surgeons, it may be able to drag its slow length along, although shorn of much of its honours, and of much of its emoluments. As of the patients of the latter class of practitioners, two-thirds, probably, are medical cases, they will necessarily be reduced a second time to mere bone-setters and bleeders—for the adoption of the above measures, although they may prevent disease, will not prevent accidents. Whether, in consequence of the change, they will be obliged to extend, or, rather, to lower their practice, and add to their present title that of barber, time alone can tell. But to be serious on this very serious subject. How any individual, who has paid the least attention to that most important subject, the causation of disease, could draw such conclusions would appear extraordinary to those who have not studied the workings of the human mind, or remarked that scientific men, who, in their ascent to the temple of truth, have

* Report of the General Board of Health for 1848-9.

† Report on the Cholera Epidemic of 1854 in the City of London.

once wandered from the straight and narrow path, seldom regain their footing, but are precipitated from the heights above into the depths below—the region of darkness and error. If the conclusions before drawn are of any value, it must be evident that the removal of filth and decomposing matter—whether existing on the surface, in drains, or in cesspools,—will have no influence in the prevention of disease. As, however, facts are of more value than arguments, experience than theories, it will be as well to inquire, as the Board of Health has been established so long, what is the result of the adoption of the measures recommended by them.

In 1849, the members of the then Board of Health expressed themselves in the following terms:—"Upon the whole, we submit that the facts and results given in this Report have placed in the hands of the Legislature, for administrative execution, measures for checking the progress and lessening the severity, if not entirely preventing the occurrence, of this pestilence (cholera): and that the measures preventive of this one epidemic, which only attacks at distant intervals some of our towns and cities, are preventive of typhus and other epidemics."* I have searched for the evidence and the facts on which these assertions repose, but I have not met with a single instance in which it could be shown that the measures proposed or adopted by the Board of Health had either prevented the return of the epidemic cholera, or lessened its ravages after its appearance, in the slightest degree. A presumed instance, it is true, has been lately adduced.

"In 1853," we are told, "nearly 2,000 persons died, within a few weeks, of cholera in Newcastle and Gateshead; while, in the neighbouring borough of Tynemouth, only twelve persons died during the same period. In

* Report of the General Board of Health, 1848-9.

1848-9, the deaths in the latter town amounted to 463. The difference between these two results seems to have been entirely due to sanitary improvements; the Public Health Act having been applied to the borough in 1851, and carefully carried out again on the outbreak of cholera in 1853." * If those who drew these deductions from the preceding facts had been better acquainted with the past history of the epidemic cholera, they would have hesitated before expressing so positive an opinion. By referring to that history, as also to the facts already adduced in the preceding Part, we shall find that it is a characteristic of this disease, and, I may add, of all other epidemics, to attack one town, or one part of a town, at one visitation, and another town, or the remaining portion of the same town, at the next. This has been so invariable a rule, during the march of the epidemic from India to England, that it is unnecessary to adduce instances in proof of the assertion. It is more necessary to add, that healthiness of locality made no difference with respect to this peculiarity; for the healthy town spared to-day, would be visited at the next outbreak; and the unhealthy town, attacked at one visitation, would be passed over at the next. For instance, at the first outbreak at Cairo, the Jews' quarter, and the lowest and dirtiest part of the town, inhabited by the poorer classes, was alone attacked: at the next, this part of the town was spared, and the disease expended its fury on the Frank quarter—airy, elevated, and clean—inhabited only by Europeans and

* This extract was taken from one of the public journals, but through carelessness at the time I neglected to add the name of the journal, the writer of the letter, or the date of its insertion; but it was some time in 1857, while it was, if I remember right, an official communication, emanating from the Board of Health or the Registrar-General's Office.

rich natives and merchants. As no sanitary measures or improvements had been adopted in the interval of the two visitations, the exemption of the dirty and filthy part of Cairo could not, therefore, be referred to this cause. Besides, those who adduced the above example, forgot to state what the mortality was in 1849 at Newcastle. Not having any document to refer to, I am unable to say what the amount actually was, but I believe it to have been comparatively small. If so, it could not be referred to the absence of filth, the state of the town being the same in 1849 that it was in 1853. More than this, the visitation at Newcastle in 1853 was entirely local, and merely the *avant courier* of the more general outbreak in 1854; a phenomenon frequently observed as in England in 1831—the epidemic having appeared late in the Autumn, and then, after prevailing partially in a few localities, subsiding until the following Spring, when the disease became general.* With such facts before us, it is impossible to draw any deduction from the exemption of Tynemouth in 1853, as regards the efficacy of sanitary measures, in the prevention of the epidemic cholera. We must, therefore, seek for other and more direct proofs. The above, however, is the only instance that I have met with in which it has ever been assumed that benefit has followed the adoption of these pet schemes of the Board of Health.

As respects endemics, it has been stated that the model

* This was the case with the outbreak of cholera at Tooting in 1848, which was merely the precursor of the general outbreak in 1849. And yet the proprietor of that asylum was placed at the bar of the Old Bailey as a criminal, accused of being the author of a visitation that neither he nor the whole medical profession, with the Board of Health at its back, could have prevented or controlled for a single moment.

houses for the poor, where every attention has been paid to drainage, &c., have been more exempt from disease than other houses in the same locality, and inhabited by the same class of persons. This result is only what was to have been expected; but, then, the benefit can be explained without reference to the modern organic theory: as will be more particularly pointed out hereafter, while considering the causes that have rendered London the healthiest city in the world. Not having perused the Reports of the Board of Health, or those of the Registrar-General, for some time, I am unable to say whether other examples, or more direct evidence, have been adduced: such may exist, but I am in ignorance of them. As, however, I am anxious, not only for the reasons previously assigned, but also for those that will subsequently appear, to ascertain the exact result of the adoption of these measures, I shall, for my own satisfaction, and that of the public, carry out this investigation, as far as it is possible to do so, from the facts with which I am acquainted. These measures having been adopted to a considerable extent in certain parts of London, and generally in several small towns, it would seem easy to ascertain, in the present day, their efficacy, or inefficacy.

Turning to that valuable record, the Statistics of the Registrar General—the friend of all sound theories, and the sworn enemy of all false ones,—and looking at the returns for fever during the last fifteen years, the disagreeable fact stares us in the face, that the mortality from this disease, in London, instead of decreasing has increased. This will be evident, by a glance at the following Table, compiled from the official records: while it will be rendered still more apparent, if we compare this period with an antecedent one, as that given in the last columns, when there was as gradual a *decrease*.

TABLE 4.—Annual mortality from fever in London, at two different epochs.

Years.	Typhus.	Remittents.	Ague.	Total.	Years.	Fever.
1841	1,151	16	15	1,172	*1816	1,292
1842	1,172	17	20	1,209	1817	1,170
1843	2,083	23	21	2,127	1818	1,093
1844	1,696	33	28	1,747	1819	1,093
1845	1,301	32	17	1,340	1820	1,109
1846	1,796	71	19	1,876	1821	1,106
1847	3,184	96	33	3,303	1822	1,104
1848	3,569	96	33	3,698	1823	694
1849	2,476	80	28	2,574	1824	750
1850	1,923	87	18	2,028	1825	806
1851	2,346	122	19	2,487	1826	926
1852	2,164	91	18	2,273	1827	755
1853	2,649	104	24	2,777	1828	843
1854	2,669	122	24	2,805	1829	1,167
1855	2,332	104	22	2,458	1830	782
1856	2,645	88	20	2,753	1831	905

It is thus apparent, that although preventive measures have been adopted to some considerable extent in London, they have hitherto produced no general beneficial effect; as evinced by the increased mortality in the very disease

* This period has been selected for two reasons. In the first place, there is an intermission in the returns from 1831 to 1838,—the interval when the old system of registration was abandoned, and the new one adopted; and, in the next, a new period commenced in 1832, an epidemic period, when, as has been previously remarked, fever is always observed to a greater extent than at other times.

which these measures are said to control more than any other. It may, however, be said that as these measures have only been partially adopted, no beneficial result could be expected on the general population of London. Now, although we may allow, in order to give individuals on their trial the benefit of every doubt, that no general effect could be experienced by the sanitary measures hitherto adopted in London, some local benefit ought to have been produced: but I am not aware of any facts which prove, that any particular district has been preserved from visitations of either epidemic or endemic diseases, by the removal of nuisances, or by the establishment of new drains. On the contrary, there are certain facts which appear to show, that these measures will neither prevent the return of such diseases, nor mitigate their intensity when present. For example, new sewers were laid down, in accordance with the plan recommended by the General Board of Health, in the district of Golden-square, in 1851, and subsequent years. Strange to say, when the epidemic cholera returned in 1854, this district was not only visited by the disease, but it prevailed there to a greater extent than in any other part of London: while it assumed a more malignant type than had been previously witnessed in England. The epidemic extended into the parishes of St. Ann and St. James, the boundary of which is in the above district; but it prevailed more particularly in the latter. This is singular; for this parish is not only a healthy one, but, with respect to the part where the disease prevailed, we have been informed that "the condition of the neighbourhood, as regards existing nuisances, over-crowding, &c., being much the same as in 1849, when St. James was, next to Hampstead and Paddington, the most lightly visited of all the metropolitan parishes; and, since that period, considerable improve-

ments have been made in the drainage of the district, by the construction of new sewers, in many of the streets."*

"This outbreak, which," to use the words of the above writers, "we believe to be unprecedented, at least in this country, as regards its mortality, was ascribed in the neighbourhood to two causes: First, the disturbance of the old burying ground, or Pest Field, by the construction of a new sewer; and, Secondly, the impure condition of the water in Broad-street Pump." Whether the disturbance of the burying ground had anything to do with the outbreak, is a question which I shall discuss hereafter; it is only now necessary to remark, that no injurious result could have been produced by the exhalations arising from the decomposing matter it might contain; the facts obtained by the removal of the cemetery "des Innocens," will at once negative such an hypothesis. As respects the condition of the water in the pump in Broad-street, which some fertile genius imagined had become contaminated by the entrance of sewer water, the Reporters add, that no proof existed of the percolation of extraneous matter into the well. As no other reasons have been assigned for the outbreak in this district, we may conclude that its extreme fatality, if not its origin, still remains a mystery: while it is apparent, that this severe visitation occurred in spite of the sanitary improvements which had been carried out there. That this patent plan of the Board of Health—the improved drainage—will exert no influence in the prevention of cholera, we may learn from another and striking example.

As will probably be remembered by many, there was an outbreak of cholera at Sandgate, in 1854, while, as a somewhat singular coincidence, this occurred after the formation of new sewers, none having existed previously. I

* Official Report by Messrs. Fraser, Hughes, and Ludlow.

am not aware of the exact interval that had elapsed from the completion of the drains and the outbreak of cholera; but it could not have been very long, as the authority for undertaking the work, as, also, for a fresh supply of water, was given by the local Board, established only a year and a-half previously. Of course, coincidence is not cause, but when we find that Sandgate had not suffered a visitation of cholera previously, and that this outbreak occurred shortly after the completion of these works, the coincidence will appear not a little remarkable. This will not be lessened by a consideration of the other facts presented to our notice. In the first place, the disease broke out close to the main sewer, and prevailed more particularly along its course, as far as its outlet into the sea; being, in fact, almost confined to this situation. In the next place, the visitation was a very severe one, the deaths amounting to sixty, out of a population of about 1,000. I have no document to refer to, in order to ascertain the rate of mortality in the smaller towns in England, in 1854, or in the previous visitations; but, in London, only 6 per 1,000 died in 1849, and 4·5 in 1854.

As regards the cause, the only explanation that I have offered, has been this. According to the statement, it was discovered afterwards that the joints of the tubes in the main sewer—the tubular system having been adopted —had leaked, in consequence of an obstruction, and that the water had infiltrated the surrounding soil, contaminating the water in some of the houses. That such a leakage had occurred is possible; but, then, does not the same event take place constantly, nay, almost daily, in London, and other large towns, without our witnessing outbreaks of cholera? Has not this same leakage, in fact, been one of the nuisances of London for the whole of this century, and since the adoption of the present system of drains;

yet we never witnessed the Asiatic cholera before 1832, while ordinary bowel complaints were so rare, during the above period, that the deaths in some years only amounted to seven and six, and in 1822, to two!! How does it happen, then, that a cause, which was insufficient to produce disease before 1832, should be enabled to cause it after this period? Are the gaseous products of sewage water different now to what they were formerly? I am not aware of the fact. Then, again, this liquid, the leakage of which produced such disastrous results at Sandgate, is used constantly, and in large quantities, in certain situations, as a manure, without producing any injurious result. Not only has sewage water been employed in agricultural districts, but, also, in towns, and their immediate neighbourhood,—as, for instance, to the lawns of houses, to the meadows adjoining Edinburgh, and the market gardens of Fulham and Hammersmith. Although the inhabitants have complained of the smell arising from this manure, we have never heard of their being more subject to cholera, or fever, than other individuals. As to the contamination of the water, I have no doubt that it would be found, on investigation, an entirely gratuitous assumption, like that of the Golden-square district: while, as a fresh supply of water had been laid on, that water would be contained, not in wells, but in cisterns, beyond the reach of the sewers and their contents. Whatever opinion may be entertained on these points, we must, at all events, conclude, that the epidemic cholera not only appeared in the above localities after the completion of works of improved drainage, but, also, that it assumed an unusual severity, and peculiar malignity.

That the adoption of the same measure will not be more efficacious in the prevention of fever, than it appears to have been of cholera, we may learn from the example of

Croydon. It was in September, 1852, that an epidemic visitation of fever occurred in this town; the particulars of which we shall best glean from the official Reports made at the time. It is necessary to remark, in the first place, that the Public Health Act was applied to this town, the same as to the borough of Tynemouth, although the result appears to have been somewhat different. In consequence of this, extensive works were carried out, under the direct superintendence, I believe, of the Board of Health; and, as cesspools had been wholly employed previously, new drains were laid down for the purpose of conveying the night-soil from the houses to the neighbouring stream. These works had been completed ten months, and it was after all this trouble and expenditure, that the inhabitants,—reposing in fancied security, and in the promises held out to them, of being assured, henceforth and for ever, from visitations of epidemic and endemic diseases, —were suddenly alarmed by the cry of fever, in the healthy town of Croydon. I will let the Reporters before alluded to—the majority of them being the advocates of the measures carried out in this town—narrate the particulars. "The main facts," observes Dr. Arnott, and Mr. Page, "which have led to the present inquiry, are, that in Croydon, *where no such epidemic is known to have occurred before*, there have been, since August last, in a population of about 16,000, about 1,800 cases of fever, with a mortality of about sixty; and that all this has happened during and since the execution there of new works, intended to improve the sanitary condition of the place." * It is not surprising, therefore, with such facts, that the visitation was ascribed by many persons to the establishment of these works,—to the entrance into the houses of

* Report on an Inquiry ordered by the Secretary of State, relative to the prevalence of disease at Croydon.

exhalations from the drains, from which they were previously free, or, to the emanations arising from the operation of removing the night-soil. As the latter operation had been continued up to the time of the outbreak, it is necessary to ascertain if this circumstance could have had any influence, in the production of the disease.

It appears, by the Report of Mr. Austin, that half as many cesspools had been removed as there had been houses drained. "This work commenced about Christmas 1851, so that some 900 cesspools had been removed, or disturbed, between that period and the outbreak of the cholera."* The same system, it may be observed, was followed on this occasion, for the removal of the night-soil, as previously; it was taken to a depôt outside the town, and thence conveyed away for agricultural purposes. The only difference, therefore, was in the quantity removed, and, in the circumstance, that the operation was carried on more cautiously than at former periods. The same effluvia, therefore, as Mr. E. W. Johnson, the Chairman of the Local Board, justly observed, had always been experienced; while he added, "that these had been materially *diminished*, both in number and intensity," at the time of the outbreak. It could not, in fact have been otherwise, for as half the cesspools in the town had been emptied, previously to the outbreak, the emanations must naturally have been diminished by the removal of so large a quantity of matter. As, also, the night-soil was conveyed away regularly from the depôt to the fields, the outbreak could not be ascribed to the accumulation of the matter in the former situation, or the emanations thence arising. Besides, if the removal of this matter had anything to do with the production of the disease, we should have expected to find that the number of cases would have been the greatest at the commencement of the out-

* Official Report.

break, for the operation was then immediately suspended. The intensity of the disease, on the contrary, gradually increased from this period, and did not arrive at its height *until four months after*, as will be evident by the subjoined detail.* If, again, the emanations arising from the matter that had been removed could be so prejudicial, those houses where the cesspools had not been emptied ought to have suffered more than the others. But such was not the case. "A remarkable fact," observe Dr. Arnott and Mr. Page, "obtains in the High Street of the town (where the fever prevailed much); several houses, with large families resident, have had no communication with the drainage system: they have not had their premises or cesspools interfered with at all, and, up to the present time, *no disease* has appeared in their establishments." On the other hand, it was precisely in those houses where the new works had been carried out, that the disease prevailed almost exclusively—fifty-two out of the fifty-seven deaths having occurred in them. We may therefore conclude, that the removal of the night soil, and the emanations thence arising, had nothing to do with the outbreak of fever in Croydon.

Nothing has been said, by the official Reporters, of any obstruction in the drains, or in the main sewer; of their leakage, and the infiltration of the soil; the emanations that arose, therefore, could only have been such as are usually experienced from these channels for effete matter.

* No account has been given of the cases, but the distribution of the deaths was as follows:—

September	5
October	5
November	10
December	5
January	32
Total deaths . . .	57

As, also, they had been recently constructed, and as accumulations of matter could not have taken place in the interval, to any extent, these emanations must have been altogether insignificant. This conclusion is confirmed by the facts adduced by another of the reporters. Mr. Baker states that, "in 39 of the houses (out of 48) where the attacks proved fatal, there was no complaint whatever as to the existing sanitary arrangements: there had been *a considerable diminution* of smells, and the inmates expressed themselves to be well satisfied with the works." And the writer adds: "In only three of the ten cases complained of did it appear, from examination of the complaints, that disease had been the consequence of stoppages, or other defective arrangements." Whatever connexion, therefore, there may have been between the outbreak of fever and the new works, we cannot refer the event to the accumulation of night-soil, or the exhalations arising from its decomposition. To show this, I may observe that, in one of the cases complained of, the smell proceeded from a fishmonger's shop, and, in another, from *a brewery!!* The emanations, therefore, extricated from the sewers, or, at least, from the decomposing matter that they might contain, like those arising from the cesspools, could have exercised no influence on the supervention of fever in that town.

This result might have been anticipated, by what has been previously advanced, but having been anxious to examine this case on its own merits, I have set aside all previous arguments and conclusions on the subject. I may now add, however, that in addition to the preservative effects of such emanations in cholera, there are many facts which would induce us to draw the same conclusion as regards fever. Parent-Duchâtelet, while referring to the effect produced on the health of the men employed in

removing night-soil, states that, with the exception of ophthalmia and lumbago, their occupation is *favourable* to health. And he then adds: "A circumstance worthy of remark is, that not one of these men during their employment in the fields (removing and spreading the night-soil) has been attacked with intermittent fever: another fact in contradiction to the opinions generally received and sought, as to the influence of this kind of occupation." * The same facts were observed during the prevalence of plague—a disease that assimilates much to typhus—and have been recorded by various writers. Silvio remarks that the inhabitants of one of the quarters of Paris asserted that they remained exempt from plague, in consequence of being particularly exposed to such emanations; while Pittorio recommends, as a well proved *preservative* from this disease, the inhalation of *the air of cesspools* and dunghills. Van Swieten also states, that during the prevalence of plague in London, in the time of Charles the Second, the physicians recommended all the dunghills that had been previously covered over and hermetically sealed, to be uncovered; and the writer adds: "The effect of the horrid exhalations hence diffused through the city was *the cessation* of the plague!'

As there was no obstruction in the drains, no leakage and infiltration of the soil, there could have been no contamination of the water, at least from this source; added to which Professor Cleary, on analysis, found it to be perfectly pure. The alleged cause of the outbreak, therefore, at Sandgate, did not exist at Croydon; and, as no satisfactory solution of the enigma has been afforded, the cause still remains a mystery. "One thing, however," to quote the words of Drs. Smith and Sutherland in their

* Mémoire sur les Cloaques, ou égouts de la Ville de Paris.

Report, "was quite obvious, that it prevailed in the town to a very considerable extent, while, at the same time, works of town drainage had been extensively carried on."

In addition to the drainage and the supply of water, other improvements had also been adopted. Mr. Grainger informs us, in his Report, that "by the operations of the Board, a large number of *most serious sanitary evils*, formerly existing, *have been removed;* a point established by the facts stated in Mr. Austin's Report, and by my own inquiries in all parts of the town." The latter gentleman adds: "The open ditches were filled up; the offensive ponds were drained and levelled; numbers of cesspools and collections of foul matter were removed, &c. And, as far as the public works were concerned, the complete supply of water and provision of drainage were completed in the greater part of the town in December, 1851. And yet," continues the writer, "the medical evidence as to the nature of the epidemic which has prevailed at Croydon appeared to establish the fact that it was especially of *that character* which is admitted to be derived from those causes which the new works *were to banish from the town.*" And, lastly, as Croydon is a remarkably clean, healthy, and not over-populous town, the outbreak cannot be referred to accumulations of dirt on the surface, or to over-crowding: it is, in fact, as Mr. Austin has justly remarked, "one of the last places in which such an attack would have been anticipated."

Having thus exhausted the list of probable and possible causes, according to the theory of the proposers of the above measures, it only remains to inquire if any other cause can be assigned for the outbreak. There can be but one answer to the question: some unknown and general cause, irrespective of all local influences. This conclusion is confirmed by the fact that the disease broke

out in other places at the same time, and before it commenced at Croydon—at Oxted, twelve miles distant, at Godstone, and at Sevenoaks. At a Meeting of the Local Board of Health, held at Croydon on the 27th of January, they adopted a Resolution to the effect, "That the disease exists extensively in other places besides Croydon." More than this, we have the testimony of Dr. Arnott to the fact that both presented the same type and character. As, however, Croydon is a very healthy town, and as it had never experienced such a visitation before, it seems hardly possible to avoid the supposition that there was some connexion between the outbreak and the carrying out of these works. That, in truth, is the conclusion at which I have myself arrived, and for the following reasons:—

It has been my object to show, in the previous chapter, that the elements productive of disease are extricated from the soil, and that they are generated at some depths beneath the surface. This granted, we can understand why an outbreak should occur in one particular locality, or why it should be more severe than would otherwise have been the case, either during or after the completion of such works. In laying down drains, the soil is naturally loosened, and will remain so for a greater or less time afterwards: when, therefore, those causes which are productive of disease are called into operation, the gaseous elements then produced will find a more ready exit in such localities than before, or than in other situations; and hence the occurrence of disease, or its greater virulence, under such circumstances.

In addition to the above, drains may, in my opinion, act directly as *promoters of disease* in two different ways. In the first place, the mouths of sewers generally open into a river; and as they are seldom covered at all times

by water, the exhalations that arise from the banks may thus find a ready entrance into the drains, and thence, by gully-holes and water-closets, into the heart of the town and the interior of the houses. In the next place, when drains have been built many years, they become, either from obstructions or the lapse of time, in a dilapidated state, their sides fall in, and thus openings are made by which not only the sewage water escapes into the surrounding soil, but what is of more consequence, the gaseous matter existing beneath is able to penetrate into the drain. The same result may occur even with new drains when they have been imperfectly made, or when obstructions take place in them before the mortar and cement have become quite hardened, although such an occurrence is more rare. That drains act in the way I have described, as conduits for the malarious poison, many facts tend to prove. Some years since, intermittents broke out in the Salpetrière, Paris, and it was for some reason suspected that the poison entered the hospital by the drains; these were, therefore, altered, and the disease immediately ceased.

No mention has been made of the state of the river into which the sewers discharged themselves at the time of the outbreak; the quantity of water it contained, the amount of muddy surface exposed, and the facility with which exhalations arising from this source could enter the drains. It is impossible, therefore, to say whether the poison productive of the disease at Croydon entered the town by this channel, or whether it was extricated from the surface as a consequence of the previous disturbance of the soil. Judging from other facts, we must conclude that the former was the mode. In the first place, *all the fatal cases* in the town occurred in houses connected with the new drains; for although there were twelve deaths in

the suburbs, in houses unconnected with the new works, the inmates would necessarily be more exposed to the emanations from the banks of the river than those in the town. In the next place "there were," as we are informed by Messrs. Arnott and Page, "some remarkable instances of large houses, connected with the new drains, which escaped the epidemic almost entirely—such as the workhouse and Trinity Hospital, the latter situated in the middle of the region which suffered most—but, then, the closets are *away from the houses.*" These facts clearly point out the source whence the poison was derived at Croydon, viz., the drains, or the emanations that entered their open mouths.

That both fever and cholera have prevailed more in the neighbourhood of certain gully holes than elsewhere, has been remarked in London, and in other places; and it has been this circumstance which has given rise to the opinion that the decomposing matter, contained in the drains, or at their mouths, was the cause of the disease. It is unnecessary to add, after the arguments already employed, that this opinion is an erroneous one: drains merely act as conduits for the poison, generated by other causes, and derived from other sources. By a paper read at the Institute of France, it appears that, in the prison at Brest, the water-closets, in four of the wards, communicated with a drain which opens into the harbour, and which is uncovered at low water, so that when the south winds prevail, noxious vapours are driven up the drain, and penetrate into the wards. In the latter, out of 2,445 prisoners, 165, or 6·70 per cent. were attacked with cholera, during the visitation in that town; while of 217 in the infirmary and condemned cell, only three were attacked, or 1·38 per cent. Now it is apparent, that the disease in the prison could not be produced by the decomposing matter con-

tained in the drains, or by that existing at the mouth of the sewer; for other individuals, not exposed to these emanations, were also attacked, although in less proportion. The attacks, in these respective instances, prove, that the poison was derived from some other source, and produced by some general cause, while the differences observed in the one case, and in the other, show that it entered the prison more readily by the drains, than by any other channel.

I am not disposed, however, to draw the same conclusion with respect to Golden-square district, as with Croydon. As the main sewer is connected with the drains of other districts, had the poison entered the houses by this channel, it would probably have spread itself through the whole of the branch drains. Neither can it be referred to the loosening of the soil, along the *whole* length of the new sewer, for the mortality was very great in New-street, Peter-street, St. Ann's-court, &c., places supplied by the old sewers; while, on the other hand, some streets through which the new sewer runs were almost entirely exempt. It is, therefore, probable, that the mischief arose from disturbing the old burying ground, the soil of which being loose and porous, would thus afford a ready exit for the pent up gaseous matter beneath. That there was some circumstance, which rendered the extrication of the poison more easy, and more rapid, than under ordinary circumstances, would appear from the suddenness of the outbreak, and the rapidity with which it spread over the district. "One of the most important and singular features of the fearful outbreak of cholera in St. James' and St. Anne's," observe the authors of the Official Report, "was its suddenness, and the large number of individuals attacked simultanously in different parts of the district—

the epidemic having attained its *acmé* on the second, if not on the first day of the outbreak."

As regards Sandgate, I have not sufficient data before me, to form an accurate opinion on the subject. As, however, the drains had been recently completed, and as the ground must still have been in a loose state, we may infer that the morbid agent found a vent by this channel. This would necessarily have been the case, if it be true, as stated, that the sewer was obstructed, for the elements productive of disease, not being absorbed by water, could not have passed from the mouth of the sewer into the branch drains. In speaking thus I do not mean to affirm that the outbreak of cholera, in this and the preceding district, is to be ascribed entirely to the formation of new sewers, for the disease might have appeared if the works had not been carried out—the cholera being epidemic that year in England. I only infer, as the consequence of the formation of such works, that the intensity of the epidemic, or its malignancy, was greater, and its spread rendered more easy, than under other circumstances. I am, however, inclined to believe, from a consideration of all the facts presented to our notice, that *no visitation* of fever would have occurred at Croydon, or at least, in the town itself, if the new works had not been carried out.

It is right to add, that in making the above observations, and drawing the above conclusions, I do not mean it to be understood that no benefit will accrue from the formation of drains: such a result is not only possible, but probable. All I am now contending for is, that the presence or absence of organic matter, or night-soil, is immaterial; for, independently of the facts already adduced, to show that its removal will not prevent the occurrence of disease, the beneficial result may be explained in another way.

When cesspools exist, and especially in the houses of the poorer classes, they are generally in a dilapidated state, sometimes lined at the bottom, but more frequently not. It has been my object to show, that the elements productive of disease are given out from the surface, and that they escape, with more readiness, from apertures and holes, or, when the soil is in a loose state, than under other circumstances. Hence it happens, that fever, or cholera, has been observed to prevail more in such houses than in others: and hence, also, we can understand why benefit should arise, by the formation of drains, and by the removal, or filling up of cesspools. But then the same benefit would occur, if, instead of making drains, the cesspools were rendered impermeable, at the bottom and sides; although they remained full of matter, and that the emanations hence arising continued the same. On the other hand, the evils previously experienced would continue, if, after the formation of the drains, and the removal of the matter, the apertures remained open, and in the same state as before: they might, in fact, even be increased, for the matter previously existing in them would, we may presume, act as a barrier, to a certain extent, to the escape of gaseous matter from beneath. We must also remember, that the same ill results will follow the formation of drains, if they are afterwards allowed to fall into a dilapidated state; while there are certain evils peculiar to them, and already pointed out, from which cesspools are exempt. If, therefore, the formation of drains has been attended with benefit, in the prevention of disease, it must be ascribed to the operation of the above causes, and not to the non-accumulation of organic matter; and were it shown to-morrow, that the ratio of mortality had been reduced one-half in those towns where cesspools had been abolished, and drains formed, the theory of the Board of

Health would not be thereby proved, or the deductions, previously drawn by me, rendered invalid.

These are the only examples that I have met with in which accurate deductions can be drawn of the utility or inutility of sewers and drains. As, however, we are told that it signifies little what the matter is, or whence it be derived, whether from an obstructed sewer, an overflowing cesspool, or an accumulation of soaking straw and cabbage-leaves on the surface; it may be as well to ask, before closing this part of the subject, if any proof exists of the advantages derived from the employment of scavengers. I have not heard of any fact of this kind which has been authenticated, or which has even been assumed as proof of the efficacy of such measures—superficial measures as they may be termed in more senses than one. The only fact of this kind that I have met with shows not their efficacy, but their inefficacy.

Dr. Sutherland, referring to the bad sanitary state of Balaklava, says: "It was the knowledge of this peculiarity that led us to *concentrate our efforts* on Balaklava:" but, he adds, "all our efforts were unavailing to save the place from cholera." * The writer states that he had the offensive marsh at the head of the harbour covered with sand, in addition to other measures, such as the removal of filth, &c. This, however, it might have been predicted, would be utterly useless; for malaria escapes as readily, if not more so, from sandy soils as others—witness Holland, and other examples already quoted. If the marsh had been covered with water, it would have been rendered perfectly innocuous. This result agrees with that obtained in Jamaica, in one particular instance, and already narrated by me.† Dr. Milroy, after his

* Letter to the Earl of Shaftesbury.—*Times, Aug.* 22, 1855.

† Statistical Report, Jamaica.

arrival in this island, visited Savannah-la-Mar, the only town of its size that had not been attacked with cholera, and having recommended the adoption of sanitary measures, these were immediately resorted to—the inhabitants being in a state of great alarm, for the disease had already reached the confines of the parish. But, notwithstanding every care and effort in carrying out the suggestions of this gentleman, by the removal of all filth and nuisances, white, or rather, lime washing the public buildings and the houses of the poor, &c., and notwithstanding a very considerable outlay, the ravages of the disease were as great as in any other town of its size in Jamaica. I say, of its size; for it has been before stated that the intensity of the disease, in the different towns in the West Indies, was in an inverse ratio to their size, or the amount of population: being greatest in the small towns and villages, and *least* in the large towns—precisely there *where filth most abounds.* I may also observe that this town is situated in a bay, and that it is built on a sandy soil; there was no organic matter in this situation, therefore, to produce the effects in question. As, also, the disease did not appear for some months after, the necessary time was afforded the authorities for carrying out the measures proposed; and, having visited Savannah-la-Mar shortly before the outbreak, I can answer for their having been properly and effectually performed.

We have thus direct, as well as indirect, proof of the assertion made by me at the commencement of this essay, that the measures hitherto proposed and adopted by the Board of Health, will neither prevent the return of the epidemic cholera, nor mitigate its intensity, when present, in the slightest degree;* and we may now draw the same conclusion with respect to all other diseases.

* I exclude from all consideration, at the present moment, the

I am not singular in this respect, for many other writers have arrived at the same conclusion, although from different premises. Thus, Dr. Alison remarks:—"I take the liberty of observing, that the queries of the Poor-law Commissioners appear to have been framed very much in accordance with the belief that the original cause of typhus, or contagious fever, is a malaria, arising from putrescent animal and vegetable matters, and from excretions from the human body, accumulated and corrupting; and that the malaria is developed wherever men congregate and bring together such corresponding matters. This belief is distinctly avowed both in the Report of Drs. Arnot and Kay, and in that by Dr. Southwood Smith, and the recommendations of these gentlemen are accordingly founded on the supposition that, by removing all such causes of vitiation of the atmosphere, contagious fever may be arrested at its source, and thus all the evils resulting from it be prevented. This opinion is not merely a speculative one, but one which ample experience entitles us to regard as erroneous; and, at all events, there is no reason whatever for believing that the contagious fever, which has prevailed more or less extensively in Edinburgh for the last twenty-five years, has any such origin, or can be suppressed by any such measures." *

house to house visitation: in the first place, because that is a measure, not for the prevention, but for the treatment of the first stage of the disease; and, in the next, because it has been my object to show, in my unpublished Report, and, on a more recent occasion ("L'Antidote du Choléra Asiatique," p. 19), that the means, or the remedies employed by the Board of Health, have hitherto failed to prevent the supervention of the severe form of the disease. The proportion, in fact, of severe cases has been the same with, as without, the adoption of this vaunted system.

* Report addressed to the Poor-law Commissioners in 1842, on the Sanitary Condition of Scotland.

It therefore becomes an important consideration to ascertain, if there be any others which can be adopted with success for the attainment of the same object. Believing that there are, I shall endeavour to point them out in as clear and succinct a manner as possible—more particularly as the subject has now become a popular one.

Having concluded that all general and specific diseases, or, in other words, epidemics and endemics, are due to the extrication of a gaseous substance from the interior to the exterior of the earth, it follows that the best and most effectual method to prevent the injurious operation of the morbid agent would be to render this extrication impossible. Now, there is only one way in which this can be accomplished effectually, and that is by covering the surface with some impermeable substance; and this plan has been adopted to a greater or less extent, under particular circumstances, for ages. Although not employed for this special object, there can be no doubt that the paving of streets or towns has been beneficial in a sanitary point of view, while, as a matter of course, the houses themselves, when the foundation is solid, will act in the same way. When, however, there are unpaved cellars, with walls composed only of loose soil, they will produce the opposite result; for, while the extrication of the gaseous matter is not thereby prevented, its escape, on the other hand, into the surrounding air is rendered more difficult. Hence, the greater prevalence of disease among those who dwell in these subterranean abodes, as was previously shown.

As a proof that pavement acts as a preservative, I may refer to Florence, the healthiness of which has been already mentioned; for it is principally to this circumstance that I attribute its remarkable freedom from endemic disease. Unlike other towns, which, if there be flag-stones

at the side, have only loose paving-stones in the centre, while these even are frequently absent, the *whole width* of the streets in Florence is covered with a solid and firm pavement.* As every large street, lane, and court, and all the principal streets, as far as the walls, are thus covered; and as the only uncovered spots are two squares and the few gardens that exist in the town, it follows that the inhabitants are thus effectually preserved from any exhalations that may arise from the surface. There is the river, it is true, but there can be few exhalations from such a stream as the Arno. In the first place, the bank, on both sides, is lined with a magnificent quay; while a dam, erected across the river at the lower part of the town, keeps the bed covered, the greater part of the year, with water. When exposed, however, there is no muddy bank to be seen, nothing but the sandy bottom, which the first fall of rain in the mountains hides again from view. Although I do not attribute the difference entirely to the want of pavement, for the poison is, probably, extricated more without than within the city, I may remark, that Rome is paved with small paving stones, there not being a pavement for foot-passengers, excepting in one street—the Corso. But, if the unhealthiness of Rome is to be attributed, in part, to its Campagna and the alluvial banks of its river, so, on the other hand, it may be answered, that the absence of such a plain is the cause of the healthiness of Florence. Although the latter town is hemmed in by high hills to the north and to the south, it is open to the east and to the west, being, in fact, situated in a valley; a position that is sometimes more dangerous than the open

* This was the ancient Roman system, as witnessed at Pompeii at the present day, although there are few remains of it to be found in the modern towns of Italy.

plain, for the exhalations which arise, instead of being dispersed, may be confined by the natural walls on either side. As, however, it would not be right, in such an inquiry, to draw general deductions from isolated examples, I shall not carry this argument farther, but turn to another town, London, where similar results would appear to have been produced by a similar cause.

Although we cannot boast that the whole width of our streets is paved with flag-stones, we can yet point to the most extended and perfect system of foot-pavement that has been witnessed, either in ancient or modern times. Such an arrangement, particularly when we remember that it is extended into the majority of the courts and alleys, added to the paving of the carriage-way, which, although not so efficacious, must still be productive of some benefit, has, we may conclude, contributed to render London so remarkably healthy. This effect has, no doubt, been increased by the custom that prevails in London of having the kitchen underground; for the foundations of the houses are not only better built in consequence, but the surface beneath is hermetically sealed by the solid floor. In continental cities, only cellars are to be found under the houses, and these in general unpaved. This, and the causes that will be presently discussed, are the only circumstances with which I am acquainted, that will account for the gradual subsidence of certain diseases, and the regular diminution in the rate of mortality, that has been observed during the last two centuries in London.*

* In speaking thus, it is right to add, that I do not ascribe the diminution that has taken place in the prevalence of disease in London entirely to local causes; that, no doubt, is to be referred, in great measure, to a general cause; for, it is a fact, that certain diseases disappear in the course of time, while others spring up in their place.

The beneficial effect of covering the surface will, however, be best shown by another fact; this is, that the paving of courts has always been found most efficacious in the prevention of disease. Mr. Pearce, the medical officer of the parish of Islington, has stated that the courts, which previously suffered from typhus fever, have been almost exempt since they were *paved* and lighted. Mr. Bayfield, of St. Olave's, Southwark, gives similar testimony. It has also been stated, that the same salutary effect has followed the adoption of the same plan at Liverpool, but having made no note of the circumstance, I am unable to say whether the statement was contained in the valuable essay of Dr. Duncan, before referred to, or elsewhere. The fact itself, however, is apparent; for the result has been observed in numerous instances, and in different localities.

For the same reason, when a town is situated near to the embouchure of a river, or on its bank, and particularly when it flows, as in the instance of London, through the heart of the city, the embankment of the river will be attended with the most beneficial results—for it is precisely there, as has been already pointed out, that noxious exhalations arise to the greatest extent. To be efficacious, however, the surface must be covered to low-water mark; for it is during the receding of the tide, and from the slimy sides and bottom of the river, that the miasmata arise. I shall have occasion to refer again to this particular subject while discussing the preventive measures proper for London.

This is apparent with respect to the epidemic of the middle ages, or the black death; and the epidemic of the present day, or cholera. The local causes now discussed will only account for the *comparative* healthiness of London, as regards other cities and other countries at the same period.

Although only applicable to certain situations, the most effectual method of preventing the extrication of malaria is to cover the surface with a sheet of water. Numerous examples have been before given of the beneficial effect of such an operation: it is unnecessary, therefore, to repeat them here. I would merely observe, that the quantity of water employed is immaterial, provided only that the surface be entirely covered.

There is an intermediate plan, which has sometimes been adopted, that of filling up a swamp, or covering it with earth and stones; this is called "la méthode de remblaiement" by the French. This plan will not, and cannot, be so efficacious as either of the others; while its greater or less success must depend on the nature of the materials used, their solidity, and the greater or less porosity of the soil. Ordinary roads, and more particularly macadamised roads, whether in a town or in a country district, will act in the same way, and produce the same result.

These are the only direct methods that can be employed to prevent the extrication of malaria from the surface; there are other and indirect methods, however, which can be resorted to with advantage at particular times and under particular circumstances. The first is, that of draining a marsh or alluvial tract, as also the land on which certain towns are situated, by a system of subsoil drains; a method that has been resorted to from time immemorial. Hippocrates states that the City of Abydos had been several times depopulated by fever; but the adjoining marshes having been drained by his advice, it became healthy. As this operation has been frequently resorted to in modern times, as well as ancient, it is unnecessary to adduce other instances in proof of its efficacy. It is more necessary to add that the operation

is not always beneficial; and that it sometimes produces the opposite effect. A succession of bad fevers, as we are told by Macculloch, commenced immediately after the drainage of the marsh called "La Chartreuse," near Bordeaux—showing themselves first in that part of the town nearest to the land reformed, and lasting many years. In 1805, the fever was so general that 12,000 persons were attacked, of whom 3,000 died. So, again, the draining of the Pontine marshes, instead of decreasing has increased the evil it was intended to remove. It would be out of place to give any detail of these works, which have been carried out at different epochs from the time of the Roman emperors to the present reigning Pontiff; or to enter into the political and physical causes that have reduced this district, once covered with flourishing towns, to a barren and pestiferous marsh. It will be more profitable, on the present occasion, to consider what are the causes that have prevented the success of these stupendous works, and on which such vast sums have been expended.*

It is generally supposed that the benefit in these cases is to be ascribed to the withdrawal of one of the agents necessary to the process of putrefaction; it being always concluded that malaria is a product of putrefaction. The latter conclusion, as I have inferred, is an erroneous one, while the benefit derived from draining a wet soil is to be accounted for in a different way. The *modus operandi* is this. It has been already shown that malaria is not given out from the surface until the whole of the water, or the principal part of it, has become evaporated. If, therefore,

* Those interested in the subject will find full information in the work of Monsignor Nicolai, "Dei Bonificamenti delle terre Pontine," Roma; or, in that of Prony, "Description Hydrographique et Historique des Marais Pontins." Paris, 1825.

the marsh be already reduced to that state which is the most favourable for the extrication of the poison, or, at least, if it arrives at this state during some portion of the year,—at that period when the malarious agent, if not generated, is usually extricated in greatest abundance from the surface,—the draining of the land will produce a beneficial effect. By reducing it to a drier state than before—for while the half-dried state is favourable to the extrication of malaria, the very wet or the very dry is unfavourable—benefit will be experienced from the operation, as experience proves. On the other hand, if the marsh be in that state, which is the least favourable for the extrication of the poison, being entirely, or nearly, covered with water the whole year, the draining of its waters, by exposing the surface to the action of the sun, will favour rather than prevent the diffusion of malaria in the surrounding air. This is precisely what has happened in the Pontine marshes. In consequence of the low level of the district, and particularly at the part next the sea, the fall is not sufficiently great to carry off the water that accumulates in the winter from rains, floods, and inundations of the sea. The consequence is, that the marshes remain partially covered with water from November to April, when the surface begins to be exposed; with the exception of certain spots, it is then in a state to admit of the plough, so that in the Autumn the greater part is covered with Indian corn. During July, August, and September, the surface becomes more or less dry, and it is during these months that fevers reign among the surrounding inhabitants to the greatest extent, and in the greatest intensity. As it is during the drying process that malaria is extricated in the greatest abundance, it is apparent that this alternate flooding and draining has reduced the marshes to that condition during the summer

months, which is the most favourable for the diffusion of the poison in the surrounding air. If it were impossible to drain these marshes perfectly, so as to keep them dry during the whole year, it would have been better to have left them in their original state; and, still better, if they could have been kept constantly covered with water. I do not mean to infer, however, that these marshes would become innocuous if perfectly drained; such an operation is somewhat problematical, for some of the most arid parts of the Campagna of Rome are as pestiferous as the marshes themselves.

Another method of effecting the same object is by planting trees. It has been previously remarked, that the cutting down trees is injurious, either by producing fever, where it did not exist, or else, by increasing the malignancy of those diseases that prevailed before. By a parity of reasoning, the planting of trees, or their presence, must increase the salubrity of a malarious district—and hence the practice so universally followed by the ancient Romans in all exposed situations. Pliny, and other authors, have inferred that trees destroy the mephitic vapour directly, but many facts tend to negative such an opinion; while it is possible to explain the manner in which trees act, without reference to such an hypothesis. When the ground is covered with trees, the surface will be protected, to a greater or less extent, from the rays of the sun; as such, the exhalations from the surface will be more or less impeded, for heat, by its expansive property, renders all gaseous matter specifically lighter than before. In this way we can understand why trees are a safeguard in certain unhealthy and malarious districts. But, as happens with the last plan described, trees may prove injurious as well as beneficial: in fact, there are no spots more pestiferious than some of the mangrove, and other forests that

line the banks of many of the rivers in intertropical regions. The reason is this. When the terrestrial, or solar heat is great, the malarious poison, as well as all other gaseous matter, will be given out from the soil, although protected by the trees from the direct rays of the sun. As, however, the poison, when thus extricated, may not be able to escape as readily as under other circumstances, it will become concentrated and confined within certain boundaries; instead of being diffused in the surrounding air, where, as has been already demonstrated, it becomes at certain distances, and in certain states of dilution, innocuous.

These are the only methods that can be adopted, to prevent the extrication of this morbid agent from the surface into the surrounding atmosphere. When these cannot be carried out, or when they fail to accomplish the intended object, the next best plan is to endeavour to protect individuals in towns, or houses, by separating the poison from the medium in which it is contained. It has been previously stated, that malaria, in consequence of its specific gravity, not only accumulates near to the surface of the earth, but, also, that it has a tendency to float in particular directions. Hence, high walls and houses, frequently prove an effectual barrier, when the poison is extricated from some source at a distance from the spot where human beings are congregated. In other instances, and where such barriers are wanting, a screen, or blind, as, also, closing the windows of the sleeping rooms, will produce the same beneficial effect. Trees act in the same way, and more particularly when there is a collection of them, as in a grove or forest, of which examples have been already given.

There is another method, the reverse of the preceding, which can be resorted to, for lessening the effects of this

agent, when present in the air of a particular locality; this is by ventilation. It has been just stated, that benefit arises from excluding the external air, by means of walls, trees, &c., but the presence of these, under other circumstances, produces the opposite effect. The reason is evident. When the poison is extricated from a source at some distance from these natural, or artificial barriers, benefit will result to those placed on the opposite side; while injury will naturally arise to those situated between the barriers and the source, as the poison would necessarily be more concentrated in such a situation, than elsewhere. In the same way, when the morbid agent is extricated within these barriers, instead of without, or, in the centre of the town, rather than in the environs, the presence of walls, houses, &c., will be prejudicial by preventing the dispersion of the poison. So, again, when an unhealthy spot is completely surrounded by trees, the latter, by acting as a screen, may prevent the diffusion of that portion of the poison given out from the cleared spot, and thus render it more unhealthy than those places where no trees exist. It is in this way that we must account for certain unhealthy spots near to Rome, pointed out by Broechi, who combats the opinion of Pliny, that trees absorb the malarious poison. *

It is on these facts that the theory of ventilation, as applied to the prevention and production of disease, rests, a subject that I have entered into somewhat fully in that unpublished report to which I am obliged to refer so frequently. On them, also, will depend, whether the admission of the external air be beneficial or injurious during the prevalence of disease: while it is only by a reference to the theory now given, that we can explain certain phenomena, which have been observed at epidemic periods,—

* Dello stato fisico del suolo Romano. Roma.

such as the benefit of isolation, and the comparative exemption of those classes that remain the most indoors, such as females,* and domestic servants. As to the practical deductions to be drawn from this theory, no general rules can be given; it is a measure, the adoption of which must be left to individual judgment, and the circumstances of the moment.

There are no other means with which I am acquainted, that will lessen the injurious operation of malaria, by physical agents, after it has become diffused in the surrounding air. It only remains, therefore, to consider what other methods can be resorted to in order to counteract the noxious influence of the poison in the latter situation. If it cannot be separated from the medium in which it exists, mechanically, the only plan likely to be attended with beneficial results will then be to attempt its destruction, or neutralization by chemical agents. Various attempts have been made to accomplish this object, but hitherto without success, and for this simple reason, that the efforts of the experimenters have generally been directed to the neutralization of the products of putrefaction, and to the destruction of those odorous substances, which, although offensive to the olfactory organs, are not, as it has been my object to demonstrate in the previous Part, the real and efficient causes of disease.

As is familiarly known, aromatic substances—such as benzoin, camphor, vinegar, the essential oils, &c.,—have been used from time immemorial, in order to disinfect the air of rooms and houses; but such agents produce no other effect, than that of making the offensive smells they are

* This general rule was not observed in the West Indies: but, then, females there, at least those of the black population, perform more hard work, and live more out of doors than the men.

intended to destroy. There are, however, certain substances which destroy and neutralise putrid miasms, such as the chlorurets of lime, soda and potash, the fumes of nitrous acid, chlorine gas, &c. These substances are true disinfectants in that sense of the term, but not in any other, for although proposed and employed for this special object, and more particularly, nitrous acid by Dr. Smith, and Chlorine gas by Guyton-Marveau, they have failed to produce any beneficial effect in the prevention of disease.

Other substances, again, act by arresting the process of putrefaction, and are hence termed antiseptics—such as tannin, creosote, tar, common salt, corrosive sublimate, arsenic, the chloride of zinc, pyroligneous acid, and although last, not least, charcoal. The latter substance, however, is both antiseptic and a disinfectant, for it not only arrests the process of putrefaction, but it also absorbs and neutralizes the gaseous products of decomposition, as will be more particularly pointed out hereafter.

There is, also, another class of agents, termed in the present day deodorizing substances, and which have been employed for the purpose of removing and destroying the offensive odours arising from the putrefaction of night soil and other organic substances. Such agents, when efficient, will act either by combining with and destroying the odorous products of putrefaction as they arise, or else they produce their effect by arresting the process itself, and thus preventing the further evolution of gaseous and odorous matter. True deodorizing agents, therefore, will necessarily belong to one, or other, of the preceding classes: as such, it is unnecessary to consider their properties further. All these substances, although employed for that special object, have, like the two former classes, been utterly useless in preventing or arresting the spread

of epidemic and endemic diseases. There is one exception, however, and that is charcoal, which, as we shall presently find, does possess that property.*

If my deductions be correct, we possess an agent capable of effecting the object under consideration. This agent is carbon, or its compounds, carbonic acid, and charcoal. It is not necessary on the present occasion to state the reasons on which this proposition was founded. Suffice it to observe that it was in 1835, during a short sojourn in Spain, that I instituted a series of experiments, in order to show that carbonic acid gas has the property of neutralizing the poison termed malaria, and the result was the conviction on my mind, that this agent is not only a remedy for the whole class of diseases produced by malaria, but that it is also a specific and an antidote. If it be an antidote, it will necessarily be a preservative; for the substance that neutralizes a particular poison within the body, will combine with it, and counteract its noxious properties out of the body. Although the result of these experiments was made public at the time, in the Spanish and English journals, and also, in a separate essay, the subject has remained in abeyance almost from that time to the present, excepting that these agents have been employed from time to time, and to a limited extent, but in a very imperfect way. I am now, however, engaged in some chemical and other experiments, the result

* As this word has been introduced, and has become familiarized, it would be as well to apply it henceforth to those substances that have the power of destroying, or decomposing, the odorous products of putrefaction, and to reserve this term disinfectant for those that are capable, or supposed to be capable, of neutralizing the elements productive of disease. It is in the latter sense only that I shall employ the term disinfectant.

of which will be made public as soon as completed.* In the meantime, I have only to adduce the facts and the evidence that may exist, in proof of the conclusion that this agent is a preservative or disinfectant, for we have nothing to do with remedies at the present moment.

To act as a preservative, the agent must be capable of uniting with the poison in these situations in which it is usually found, viz., the soil and the air, otherwise the neutralization of the morbid matter cannot be effected. Although such an operation is practicable, it would be unnecessary to attempt to neutralize the morbid matter, when present in the soil, for as the object is to prevent the diffusion of the poison in the air, it would be better and

* Thinking that it would be the means of saving life, I made an offer to the East India Company, at the commencement of the Indian revolt, to proceed there for a few months, in order to demonstrate the truth of the above conclusion. The answer that I received was the following. After referring to my communication, and its contents, Mr. Secretary Melville added: "In reply, I have received the commands of the Court to state, that they are fully sensible of the humane motives which have dictated this offer: but there being in India an ample number of experienced medical officers of Her Majesty's and the Company's army, they must decline to avail themselves of it." It is the old reply to every new proposal: Are there not rivers in Damascus greater and mightier than the rivers of Jordan? Can I not wash in them, and be made whole? I might have replied, but I did not, for it seemed useless to argue with men who could employ so *puerile* a reason. There were "experienced" men in the profession in the time of Jenner: nevertheless, it took fifty years to induce these clever men to adopt, what they considered, an innovation on established practice. How long it may take to induce the Indian practioners to adopt my remedy is a question that the late Directors of the late Honourable East India Company did not, as it appears, think it worth their while to inquire! But peace be to their manes: *de mortuis nil nisi bonum.*

easier to effect this at the moment of its extrication. For this purpose charcoal should be employed, and be spread over the surface, so as to absorb the gaseous matter at the moment of its extrication. If in sufficient quantity, the poison would not only be absorbed, but decomposed and destroyed, and its diffusion in the air be thus effectually prevented. To produce a beneficial effect, however, the charcoal must be recently prepared; for as it acts by absorbing the substances which it subsequently decomposes, and as its absorbing powers diminish with age, its preservative or antidotal properties will also diminish at the same ratio. For the same reasons it would have to be renewed from time to time; for, when the charcoal has arrived at what may be termed its point of saturation, no more gaseous matter can be absorbed; its further employment therefore would be useless. As, also, this substance possesses the property of combining with all septic substances, or the products of putrefaction, there will be a double advantage in the employment of this agent: it would neutralize the elements of disease, and destroy the offensive odours which are generally given out at the same time.

We have been told however, by one of the Inspectors of the Board of Health, Dr. Sutherland, that "peat charcoal, in any ordinary quantity, is certainly not a disinfectant. It stops smells and that is all." * What is meant by quantity, I am at a loss to understand; for if it be a disinfectant in one quantity, it will be in another: proportion can have nothing to do with the chemical properties of a substance.

In proof that charcoal is not a disinfectant, Dr. Sutherland cites what he terms the following conclusive experiment:—The steamship Chester arrived at Balaklava laden

* Letter to the Earl of Shaftesbury: *Times*, August 22d, 1855.

with peat charcoal, and began to discharge her cargo: in two days 6 men were attacked with cholera, although the quay was covered with dust, and the same pervaded the ship and covered the men." As this would appear to militate against the conclusion before drawn, a few remarks are necessary. It has been already stated, that charcoal loses its properties by age, while I have explained its virtues in preventing cholera in the following way:—When recently prepared, charcoal contains, as I infer, a certain quantity of carbonic acid gas: but this is again given out slowly and regularly, and its place supplied with atmospheric air, or any other gaseous matter with which it may come in contact, as well as with water or other fluid. Those therefore who handled this substance, when recently prepared, would naturally inhale a certain portion of the gas, and hence the exemption of the charcoal porters from cholera in France, and in all the southern parts of Europe. This result would be increased by the charcoal itself absorbing a certain portion of the poison, diffused in the surrounding air. We can thus understand why the crew of the Chester should be attacked with cholera, notwithstanding that they were handling the charcoal, and that a portion of the dust was spread about on the ship and the wharf. It had doubtless lost its *preservative* or disinfectant properties from age. To have rendered it efficacious, it should have been re-burnt, a plan I have recommended elsewhere.* I may also observe that charcoal which has lost its preservative properties may still act as a deodorizer, by absorbing the gaseous products of putrefaction. This was the case with that at Balaklava, for we are told that "so perfect was the deodorizing effect, that there was no smell either in the ship, or near it; although usually

* Antidotal Treatment of the Epidemic Cholera.

the air was very foul there." This affords another proof, if it were wanted, that the products of putrefaction and the elements productive of disease are distinct and different substances.

There are some other remarks of this writer which also call for a slight comment. After stating that three deodorizing substances were employed in the Crimea, viz., charcoal, lime, and sand, Dr. Sutherland adds: "Lime acts very well, and, I think, best when wet. Sand or gravel, for certain purposes, is as good as either. Six inches of sand spread over it (the marsh) entirely deodorized the soil." That the offensive odours were prevented for a time is possible, but then this effect was due to the mechanical, not to the chemical properties of the agent. Sand is no deodorizer; that is to say, it will not unite with, or decompose, the products of putrefaction: as witness the Mangrove forests that line the banks of certain rivers, or the sea-shore of certain districts in intertropical climates, and where offensive odours are given out to the same extent as in alluvial soils. In many situations, and more particularly in temperate climates, the decomposition of organic matter is not observed; but then this arises from the absence of vegetation, not from the chemical properties of the soil. Still less is sand a disinfectant, capable of uniting with and destroying the elements productive of disease; for there are no situations more pestiferous than certain sandy soils, both in tropical and temperate climates—as witness Holland and other localities before referred to.

Lime, on the other hand, is a deodorizer, but not a disinfectant, in the proper sense of the term: that is to say, it will unite with and decompose some of the products of decomposition, and thus destroy the offensive odour given out during the process; but it has no power over

the elements productive of disease. In proof, I have only to remark, that nowhere have the ravages of the epidemic cholera been greater than on certain limestone formations, while epidemic fever prevails to the same extent in such situations as in others. Endemic fever, it is true, is more rare, but then this is to be ascribed not to geological formation, but to elevation,—such rocks being usually found at some height above the surface. We know, also, by direct experiment, that lime will not and cannot destroy or neutralize the elements productive of disease. Had it been possible to do so, there would have been no cholera, or, at least, no deaths in some parts of Jamaica; for not only the floors of all the rooms, but even the beds, and sometimes *the body of the patient*, were covered with *quick-lime*.

To return, however, from this digression. Under ordinary circumstances, it will not be sufficient to neutralize the poison at the moment of its extrication: we must also attempt to effect its destruction in the surrounding air; for it is only by its effects in this situation that we are, in general, aware of the existence of this invisible agent. It is, in fact, by its introduction into the lungs, and its absorption into the circulating system, that the morbid effects observed in man are produced. Hence the necessity for effecting the above object; for there is no other way in which we can avoid the infection, although, unfortunately, the means at our disposal, for the destruction of the poison, are necessarily more limited than in any other situation. As Macculloch rightly observes, "Had nature corrupted the springs, and the rivers of a whole country, we might have declined to drink them, or we, at least, might have imagined this in our power; but we cannot refuse to breathe, even when we know that it is the breath of the grave, not the

air of life." If, however, my deductions are correct, there can be no reason why the poison should not be neutralized, to a certain extent, and in certain localities, the same when present in the air as elsewhere. This is a method that was recommended by me many years since for the prevention of the spread of the epidemic cholera; * but it was only during the prevalence of the disease in the Island of Jamaica, and, subsequently, in the Islands of Trinidad and St. Vincent, that I had an opportunity of testing the efficacy of the plan. The result has been given in my two Reports, the published and the *unpublished* one; it is unnecessary, therefore, to give the details on the present occasion. I would only observe, that the same agent was employed then as that now recommended; for, according to my experience, the substances that act as antidotes to the poison of malaria, also produce the same effect with the choleraic poison. Be this as it may, the plan employed by me was to diffuse a certain amount of carbonic acid in the air by means of a common fire. As, however, the compound thus formed by the union of the carbon of the wood with oxygen, naturally deprives the air of a certain amount of this vital agent, this method would not always be practicable, as, for instance, in crowded habitations and in courts, and other over-populous districts. There are, however, few situations where a fire could not be resorted to, only its employment would necessarily be more limited in one situation than in another. On the other hand, although there would be less objection to the extrication of the pure gas, there would be a greater expense attendant on its employment—circumstances which will render the use of a fire more general, and cause this plan to be the one more commonly resorted to. This is the agent, and these

* Buletin de Medicina y Cirugia. 1835.

are the methods that I now recommend for neutralizing the poison, termed malaria, when present in the atmosphere ; as, however, I have not yet had an opportunity of proving the truth of my conclusions by direct experiment, I must depend, at present, on indirect evidence, and on certain isolated facts adduced by other writers. Fortunately, there are a great many indirect facts which clearly demonstrate that the presence of carbonic acid in the atmosphere is a preventive of disease; while this evidence, I may observe, is nearly the same as that which I have before adduced, to prove the efficacy of the same agent in the prevention of the epidemic cholera.

For instance, it was remarked that the Arcades in Paris, lighted with gas, escaped the ravages of the epidemic cholera, being almost the only spots that were exempt, during the severe outbreak in 1832. As gas from common coal is composed almost entirely of compounds of carbon and hydrogen, viz., the oxide of carbon, the proto-carburetted, and the bi-carburetted hydrogen, or olefiant gas, the result of the combustion of these gases is carbonic acid and water. To the presence of the latter gas, therefore, I ascribe the exemption of these localities at the above epoch. As the lights are numerous, in proportion to the size of the Arcade, and as the products of combustion in such a confined space would not be able to escape so readily as in other situations, we can understand why a beneficial result, not observed elsewhere, should have been experienced here. Although more difficult to be appreciated, we may also infer that the use of gas in a large town, and which, on account of its comparative cheapness, is consumed to a much greater extent than oil, is one of the agents to which we must attribute the greater salubrity of London and Paris when compared with many other towns. This inference is confirmed by

the fact before mentioned, while speaking of the utility of paving, viz., that courts which suffered previously from fever, experienced a complete immunity after they were paved and *lighted.*

The same results have been observed to follow the combustion of other carbonaceous matter—as charcoal, wood, and coal. I have adduced, in another place, the facts furnished me by the late Dr. Sauch of Barcelona, viz., that the blacksmiths, laundresses, &c., who had a large brazier of charcoal burning all day in their shops, escaped the ravages of the disease, when every other house in the street was attacked. A similar result has been observed at other times, and in other situations. To the employment of this article, as well as to density of population, we may no doubt attribute the fact that cities are more healthy than uninhabited districts—at least in unhealthy, malarious, and intertropical climates. But the benefit derived from the combustion of carbonaceous matter would appear to be greater when coal is employed, than when charcoal is used; and it is to this circumstance, as well as to greater density of population, that I am inclined to refer the superior healthiness of London in comparison with other large towns.*

To listen to certain writers, we might conclude that the capital of England was the chosen seat of pestilence and

* There was no regular supply of pit-coal in London until the reign of Charles the First—the prejudice against its use previously being so great that a law was passed, making it a capital offence to burn it within the city, excepting in forges. By a document in the Tower, discovered by the late Mr. Astle, it appears that a person was actually tried, convicted, and *executed* for this heinous offence in the reign of Edward the First. A few years since we might have exclaimed against such barbaric credulity; but having witnessed a similar act in our own days, we can say nothing: although, thanks to the superior intelligence of the Jury, the individual in the latter instance was acquitted, not condemned.

death; but, when we search for facts, in support of the assumption, it turns out, that instead of being the most unhealthy, it is the most healthy city in the world. At least it was so, before the inauguration of the present Board of Health; what it may be now, the statistics of the Registrar General will best tell. Thus, the rate of mortality in London was 2·70 per cent. some years since: in Leeds and Birmingham 2·77; and in Liverpool 3·57. In Rome it is 4, in Vienna 4·5, and in Constantinople 5·7 per cent. The average duration of life is, also, much higher; but I have not access to the necessary documents to draw an accurate comparison between London and other towns: I only know that it was nine-and-a-half years more than in Liverpool, and that it is considerably higher than any Continental City. The result would be still more favourable, were it not for the fact, that London is not only the great hospital of England, but, also, the general rendezvous of the classes most subject to disease, the idle, the dissipated, the intemperate, and the necessitous. * In referring this beneficial effect to the above cause, it is to be remembered that, independently of the quantity of carbonic acid produced, there is a large portion of carbonaceous matter also, diffused in the air, from the imperfect combustion of the coal—for smoke is merely finely divided charcoal combined with certain empyreumatic oils. However disagreeable in many respects, smoke

* In a healthy, or temperate, well-cleared, and cultivated country, like England, the town will give, for the above reasons, the highest rate of mortality: but, in an unhealthy, hot, and malarious country, the town, notwithstanding the above drawbacks, produces the lowest, for the reasons previously discussed. When, therefore, we take these circumstances into consideration, and when we find that the mortality in England generally in 1838-44, was 2·20 per cent. and, in London, not more than 2·50, the fact is not a little striking.

may therefore be said to be, not only the friend of the washerwoman, but, also, of the inhabitants generally of London. To the same circumstances, may no doubt be ascribed the comparative immunity of certain manufacturing towns from endemic disease,—as, for instance, Birmingham, which enjoys an almost complete exemption from fever. Such a result is the more worthy of note from the fact, that this town is notorious for defective drainage—the refuse from the houses being received into open ditches, where it stagnates and putrefies.

That the benefit observed in the above instances is to be referred, in part, to the use of fires, other and more direct facts tend to show. The Post-master of Torre de tre Ponti, situated on the margin of the Pontine marshes, and who, to the surprise of M. Ozanam, appeared to enjoy perfect health, thus accounted for the circumstance: "I have resided," said he, "more than forty years in this place, and I have never had the fever. The only precaution I take is, not to leave the house until the sun is somewhat above the horizon; to return home before nightfall, and *then to light a fire.* I live well, and take wine: that is all my secret." * The natives of some parts of Africa, also, adopt the same practice, as I had an opportunity of observing with a party of untutored Africans, captured in a slave ship, and located on one of the estates in Jamaica. The following example is more striking still:—"A superintendent, engaged in directing the cutting of wood in Africa," observes Dr. Macculloch, "erected twenty earthen furnaces on the spot where his men were employed, lighting them every day. Before this, he had always from forty to forty-eight of his workmen sick, but, in a very short time, they were reduced to twelve, then to four, and

* Histoire Médicale des Epidemics, t. 1, p. 29.

finally, to *one*." * Dr. Acton relates another, and similar instance. He observes: "In one of the most unhealthy corners of the Pontine marshes, I found a man who had for several years, been employed there for making charcoal from turf. During this period, he had never been affected with any disease, and, when questioned respecting a circumstance so very extraordinary, in such a place, he ascribed the preservation of his health to the following circumstances. He made a particular point of returning by sunset to his hut, where he kept *a continual fire*; he never left it again till late in the morning, and remained near his furnaces in the day time. This man had a florid complexion, and a totally different look from the people of the country, who are annually exposed to a mortal disease, and generally (it may be said *always*) drag on a truly pitiable existence." †

The utility of fires has been noticed from very early periods, and Pliny refers to Hippocrates, and other authors in proof of their beneficial effect. It is also said, that Napoleon the First adopted this expedient with success, when his armies occupied some of the worst districts in Italy. This fact—the beneficial influence of fire—taken by itself, would be no proof of the inference drawn by me, as to the antidotal properties of carbon and carbonic acid gas; for it may be said, and has, in fact, been always inferred, that the benefit derived in these instances is due simply to the rarefaction of the air, and the consequent dispersion of the poison, or, to the absence of moisture and the greater dryness of the air. The latter is, I believe, the opinion of Sir James Clarke, who refers to the exemption of the populous parts of Rome from fever. If, however, we take this single fact, and then compare it with others, in which no rarefaction or dryness of the air takes

* Loc. cit. † On Malaria.

place, but where the same operation occurs, the generation of carbonic acid gas, we can hardly refrain from inferring that the benefit is to be ascribed to the presence of this agent.

For instance, I have, on different occasions, pointed to the remarkable fact that the congregation of a number of men and animals in a small and confined space appeared to prevent an outbreak of cholera. Thus, those small villages in Spain, where large flocks of sheep are penned every night, to secure them from the wolves, escaped the attacks of the epidemic cholera, while every other village in the district was ravaged. So, again, the men in the cavalry regiments in that country, who are accustomed to sleep in the stable, *with their horses*, remained comparatively exempt, while the infantry soldiers, who inhabit large, lofty, and well ventilated barracks, were attacked by the epidemic, in the same proportion as the rest of the inhabitants. The same facts have been remarked with respect to endemics. For instance, it is an old observation, that the men in cavalry regiments are invariably more healthy than those in the infantry: at least this is the case on the Continent, where it is the practice, in general, for the men to sleep either in the stable, or in a room adjoining. As is to be inferred, the exemption in these cases, has been ascribed by me to the quantity of carbonic acid given out by the sheep and the horses during expiration: animals of that size producing a large quantity of this gas.

To the same cause I should refer the circumstance before referred to, viz., that endemic diseases are diminished by density of population. That the effect is to be referred principally to this cause, as well as that just considered—the employment of fires—and not to the intervention of walls, which, it has been previously shown, acts in the same way, at particular times and under

particular circumstances, may be inferred from the fact that when population decreases in any spot, diseases increase, although the houses, walls, and other external conditions remain the same. This result, which has been constantly remarked at Rome, has been found to hold good even with respect to the villas of the rich; for, when abandoned, or, when the family has ceased to inhabit them, the domestics left in charge, and who were previously exempt, have speedily become attacked with fever.

That the result, in the above instances, is to be referred to the cause now assigned, many direct facts tend to prove. Thus, those places in which mineral springs exist, disengaging carbonic acid gas—such as Pyrmont, Toplitz, Kissengen, Cheltenham, &c.,—have all escaped the ravages of the epidemic cholera, although many of them were actually hemmed in by the disease. These places are, also, all more or less exempt from endemic diseases, or fever, notwithstanding that many of these springs are situated in malarious and unhealthy localities.

We have thus direct, as well as indirect proof, to show that the presence of carbonic acid in the air is beneficial, and that, when in sufficient quantity, it acts by destroying or neutralizing the elements productive of disease,—no matter by what name they may be called, malaria, or any other. True, the amount of direct evidence is not great; but, then, the indirect facts are, perhaps, of more value in such an inquiry than the direct ones. For instance, if we find that a similar result is produced by the combination of carbonaceous matter, as by the congregation of a number of individuals in a small space, and if we find, that the only agent common to each is carbonic acid, we cannot fail to refer the benefit derived to the presence of this gas; for it is not probable that two, or more opera-

tions, differing so greatly from each other, should produce the same result in any other way. When, also, we add to these indirect proofs, the direct ones, we have an amount of evidence sufficient to prove a similar proposition in any other branch of science, or even in the abstract sciences; for it has always been laid down as an axiom, that multiplied coincidences are tantamount to positive proof.

The proposition, however, might be proved in another way, and without any reference to the preceding facts. I have shown, by a variety of clinical experiments, that carbonic acid has the property, when introduced into the system, of neutralizing the poison productive of the class of diseases termed endemics,—all those diseases in fact, that are due to the operation of malaria. The result of the administration of this remedy, in cases of intermittent fever, leaves no doubt of the justness of this conclusion. If, therefore, carbonic acid can produce this result within the body, it can effect the same object without; provided only that the two agents—the antidote and the poison—be brought into contact with each other. The conclusion is too evident to need either proofs or arguments in its support. Still, I would hope, at no distant day, to be able to adduce more direct and positive facts in proof of the proposition now laid down—the most important, perhaps, that has been proposed since medicine was a science. On its solution will depend the fact, whether an antidote exists or not, for the poison of malaria; and whether, in consequence, a successful and certain remedy has been discovered for, at least, two-thirds of the maladies that affect the human race.

APPENDIX.

As the preceding Treatise is a general one, applicable to all times and to all places, I have reserved, for the present moment, the remarks which naturally arise, as a consequence of the preceding conclusions, respecting the plan that is in contemplation for the drainage of London. That plan has two principal, if not sole objects in view,—the Prevention of Disease, and the Purification of the Thames.

It having been assumed that the present tidal system of drainage is productive of various evils, and that to the existence of these is to be ascribed the prevalence of fever, cholera, &c., it has been proposed, in order to remove them, to intercept the sewage water, and to convey it to a distant part of the river—to Sea Reach, or some other Reach, below London. * These evils, or nuisances, are the following. The retention of the sewage-water for so many hours of the day, during the time of high water; the deposit of the matter, contained in the sewers, on the banks of the Thames; and lastly, the contamination of

* "But the evil before all others, to which I attach importance," observes Mr. Simon, "in relation to the present subject, is that habitual empoisonment of soil and air, which is inseparable from our tidal drainage. From this influence, I doubt not, a large proportion of the metropolis has derived its liability to cholera." † We might ask this writer, how it happens, if London has derived its liability to attacks of cholera from this source, that other cities, which have no sewers, or which, having them, are free from the evils attached to the tidal system, have been visited by this epidemic? We might also inquire, how it is that with all those evils, London has hitherto been more lightly visited by the epidemic cholera, than any other city in the world. Had the intensity of the disease been as great in London, as in the capital of Barbadoes, *where there are no sewers*, half a million would have perished, whereas only 14,000 died, in 1849, and a less number in 1832.

† 5th Report.

the water of the river by the contents of the sewers being poured into it. Upon the feasibility of the new plan, in a mechanical point of view, its advantages or disadvantages, when compared with the present one, I shall not attempt to enter; these are points that can be better discussed by engineers than by a medical man. I would merely observe, that the plan, if carried out, will not do away with all the above nuisances or evils: the majority will remain, although not to the same extent as before.

Much stress has been laid on the fact, that the mouths of the sewers opening into the river, the water, during the flood tide, enters into them, for a considerable distance, driving up, it is inferred, the gaseous matter which exists there. Thus, the preceding writer, speaking of the sewers, remarks:—"They furnish sources for an immense fœcal evaporation; at every breeze which strikes against their open mouths, at *every tide* which encroaches on their inward space, their gases are breathed into the upper air—wherever outlet exists, into houses, foot-paths, and carriage-way." This evil has been much exaggerated, if it has not been altogether misrepresented and misunderstood. In the first place, the water which enters the sewer would naturally cleanse it of all the solid matter that it came in contact with, while it would also absorb a large portion of gaseous matter; for, as was previously shown, all the gases given off during the process of putrefaction are absorbable by water. When, in fact, are the emanations from the drains principally perceived? previously to rain—a result that occurs, not only at high water, but at low water, and when there is no tidal water in the sewers. Again: when do these emanations cease the soonest, and when does the atmosphere of London become the purest? After heavy rains, and after the sewers have become flooded, although it may so happen that the surface and tidal waters meet each other—thus proving that the gaseous matter contained in drains is rapidly absorbed by water. It is a question, therefore, whether the entrance of the tidal water is not productive of as much good as evil. Were it otherwise, however, the preventing its ingress into the sewers will not do away with offensive odours, for these emanations arise from the matter deposited there—a result that will occur with any system

of drains. True, we are to have a new, and, perhaps, more perfect system of drainage for the present one; but, then, who is to assure us that an efficient and inodorous system shall be substituted for what Mr. Simon calls an elaborate disguise of an unremoved nuisance? Can any system be adopted that will assuredly prevent the deposit of organic matter in the drains? This matter, it should be remembered, is only mechanically suspended in the water, not chemically united; it therefore becomes separated and deposited, even by the strongest currents, —as witness the estuaries formed at the mouths of all rivers, even of the impetuous Ganges, and of the mighty Orinoco. Then, again, it will have to be considered, whether, with our limited supply of water, this evil may not become greater than at present, for the more the system is extended, and the farther the matter is carried, the greater are the difficulties to be overcome, and the greater will be the risk of failure. A part of the emanations that now arise from the drains will doubtless be prevented—those that enter by the mouths of the sewers; but it is not necessary to alter the present system on that account; for the same advantage can be obtained in other ways;—by a system of floodgates, or by carrying the sewers beyond low-water mark.

As regards the emanations that are extricated from the banks of the Thames, it is to be remarked that they are derived from *three* different sources—the matter deposited from the sewers, the refuse of the manufactories, and the alluvial matter contained in the water of this river, in common with all other rivers. It is the latter matter which forms the muddy banks of rivers; while it will be deposited in larger quantity near to a town, like London, than in any other situation, in consequence of the number of bridges which obstruct the downward flow of the tide. Supposing, therefore, that the refuse of the manufactories be diverted from the rivers to the drains, the alluvial matter will still remain; and, as it always contains a considerable amount of organic substances, putrefactive gases will still be extricated from this situation. For the same reason, exhalations—the products of putrefaction—will still be given off from the surface of the river, excepting that certain products, which only exist in sewers, would not then be extricated,—as, for instance, the hydro-

sulphuret of ammonia. It is very doubtful, however, if this gas be ever given off from the surface of the Thames, as Mr. Brande failed to detect it in the specimens of water he examined. The difference, therefore, as respects the emanations from the Thames will be merely a difference of degree.

Then, again, the intercepting the contents of the sewers will not render the water of the Thames pure, as must be evident by the remarks just made. As the alluvial matter is derived from the land over which the waters flow, and as this river collects the waters of 6,160 square miles of country, it will be apparent that the quantity of organic matter contained in the sewers is utterly insignificant, when compared to that which the Thames itself holds in solution. *

There is, also, another question that requires to be considered. What is to be done with all the other towns, that pour the contents of their sewers into the Thames, either directly, or indirectly, by other streams. Are they to send this matter to the sea, or, are they to pour it into the main sewer of London? Will the Legislature oblige the inhabitants of Oxford, Richmond, Maidenhead, and all the towns in the vicinity of the Thames, or its tributaries, to incur this expense? If they do, some of them will probably become deserted; and, if they do not, the Thames will still continue polluted with sewage-water. After all, therefore, it will only be a sort of half-measure, as respects the exhalations from the Thames, and the purification of its waters.

The principal and most important question, however, is, what will be the result of the measure in a sanitary point of view? According to its proposers,—the prevention of fever, and the whole class of Zymotic diseases. One of its strongest advocates remarks: "It is my belief from such evidence as is before me,

* The quantity of organic matter found in the sewers, and in the river, varies but little. Thus, the water at London Bridge has been found to yield 2·194 grs. to the gallon, and that in the Earl Sewer 2·738 grs.; while the mean of organic matter contained in the specimens of river water, was found to be about three-fourths of that in the sewers. If the difference in the quantity of water contained in the sewers, and that in the river be calculated, it will be at once apparent, that the principal part of the organic matter found in the water of the Thames is derived from some other source than the sewers.

that the general liability of London to suffer the epidemic visitation will cease, whenever an efficient and inodorous system of drainage, conveying all refuse of the metropolis beyond range of its atmosphere, shall be substituted for our present elaborate disguise of an unremoved nuisance." * If the epidemic cholera ceases, all other epidemics will cease, as also fever, for we are told, by another authority, that "there is such an intimate relation between the whole class of zymotic diseases—such an inseparable connexion between them, as to their predisposing causes, their spread and their prevention—that what applies to one, speaking generally, applies to all." † Hence, the prevention of fever, and of the whole class of zymotic diseases, is to follow the adoption of this particular and somewhat stupendous work. Such a result is, no doubt, a consummation most devoutly to be wished; while it would be worth the expenditure of ten times the sum that has been calculated. But there are certain facts, which, if facts be of any value, when opposed to theory, tell us that no such benefit will be obtained.

As I am now treating the question, not in a theoretical, but in a practical point of view, the first questions which suggest themselves in such an inquiry are, When was the present system of drains established in London? What was the condition of the town previously, and what has it been since, in a sanitary point of view? I am not aware when drains were first made, but it was only at the end of the last, or the beginning of the present century that permission was given by the Commissioners of Sewers for the contents of the water-closets to be passed into them,—cesspools having been invariably employed up to that period. If, therefore, the emanations from this matter be so injurious, we should expect to find that the ratio of mortality would not only have been very high when cesspools were alone used, but also that this mortality would have gone on increasing at the same rate as the increase of population—for the greater the population, the greater will be the emanations that arise from such a source. It appears, however, notwithstanding the great increase of population which took place in the 18th century, that the ration of mortality decreased in a remarkable

* Mr. Simon, 5th Report.

† Report of General Board of Health, 1848-9.

degree, as has been previously stated. Thus, the deaths of children, under two years of age, which, between 1728 and 1738, when the ages were first noted, were set down at 10,000 annually, gradually decreased to the end of the century, being only 6,000 on the average from 1790 to 1800.* Again, dysentery and bowel complaints, which amounted to 1,000 annually, at the commencement of the 18th century, declined gradually until they only amounted to 100, and finally, to 20.† Fever, also, the very disease which, of all others, is said to be produced by such emanations, underwent the same rapid and gradual change: the mortality from fever having diminished from 2,902 in 1700 to 1,784 at the end of the century. Nor did the emanations from this increased accumulation of fecal matter, have any influence on longevity; for the value of life increased in the same ratio as the increase of this matter and its products,—those noxious gases that are, as we are told, so destructive to life. But the figures in the tables of the actuary are better than all the theories and all the doctrines of all the doctors in Christendom. And what do these figures tell us? That in 1700, the annual mortality was 1 in 25; and 1 in 36 from 1797 to 1801: so that the value of life had increased 11 *per cent.* during this period of *extreme peril and danger.*

It is right to add, that the same gradual decline in the ratio of mortality from fever occurred from 1800 to 1831, the deaths in the latter year only amounting to 905: it may therefore be argued, that this decline was due to the change that then occurred by the discharge of the night-soil into the river. Such a conclusion, however, will not hold good; in the first place, because we have seen that this decline in the rate of mortality had been going on for upwards of a century; and in the next, because it ceased in 1832, and has been gradually increasing since that period,—as will be evident by a reference to the table inserted in the last chapter. What the difference may be as regards the general mortality, I am unable to say. On the other hand, if we allow that benefit was derived from the discharge of the night-soil into the Thames, we must also infer that no injury has been produced by the contamination of

* Heberden's Commentaries. Page 33.

† Sir G. Blane, Select Dissertation.

the river, or by the present tidal system of drainage; for we have seen that the mortality from fever gradually decreased up to 1830, in spite of that contamination, and in spite of that much abused system. Then, again, how are we to account for the increase that has taken place in the prevalence of fever, and in the rate of mortality since 1832? To defects in the present drains, the result of dilapidations from time, &c.? Such an argument might hold good for a particular district, but it will not account for the general prevalence of fever, as the system has been gradually extended and new drains built during the whole of this period. The injury, therefore, that has been produced by the dilapidation in the old drains, ought to have been counterbalanced by the benefit derived from the formation of new ones—if benefit can be derived from such an operation. But all arguments on the subject are rendered unnecessary by one simple fact: this is, that the same increase in the prevalence of fever has been remarked in all other towns, and in all other countries visited by the epidemic cholera:—in those where drains do not exist, the same as where they do, and in situations where no accumulations of fecal matter can possibly occur. It is therefore evident, as the deduction from the preceding facts, that while, on the one hand, the decrease in the prevalence of fever, during the last and the first part of the present century, cannot be ascribed to the abolishing of cesspools, so, on the other hand, its increase of late years, cannot be referred to the faulty system of drainage, or to the contamination of the water of the Thames.

In addition to the above, if the deductions previously drawn have any weight, we must infer that the removal of the night-soil to a distance is not necessary: for it has been shown, that the emanations given off by this substance are innocuous. We have also seen, by some striking examples, that the establishment of drains, or the formation of new ones, will not prevent either cholera or fever. It has also been inferred that the use of Thames water does not give rise to any general or permanent ill consequence: we might, therefore, if these were the only reasons, still allow the sewers to empty themselves into the river. But every idea of delicacy and propriety revolts at the bare thought of taking our daily beverage from a source that

is the common receptacle of all the filth of a city like London. If, however, the purification of the Thames be the sole object to be accomplished, the question becomes entirely changed: while certain plans, not otherwise admissible, may be carried out.

If the emanations arising from night-soil be not injurious, it may instead of being thrown into the sea, or into the river, be applied to agricultural purposes, and become, instead of a nuisance, a benefit to the inhabitants of London, and to the nation at large. As Liebig has justly remarked, thousands of hundredweights of phosphates flow annually into the sea by the Thames: while, if these and the other matters contained in the sewage water of London, could be converted to the purposes of agriculture, the importation of foreign corn, it has been calculated, would be prevented altogether. But it is the local benefit, or the revenue that may be derived from the sale of the matter, with which we have most to do at the present moment: it may be as well, therefore, to ascertain what this really would be.

The value of sewage water may be calculated in a variety of ways. The alkaline and ammoniacal salts, with the earthy phosphates, contained in the sewer called the King's College Pond, have been analyzed by nearly all our first chemists; and the quantity that passes off daily, as well as the value, ascertained. The total daily value is 54*l.*, and the annual value 23,360*l.** Supposing that the ingredients are in the same proportion in all the other sewers, it has been further calculated that their total value is between 400,000*l.* and 500,000*l.* This, however, gives but a very imperfect idea of the value of the sewage water of London; or, of the excreta of such a population. In the first place, the solid matter has been excluded altogether from the calculation; and in the next, a large proportion of the

* The quantity and the value of these ingredients is as follows:—

	Quantity. Tons.	Value. £
Ammonia	2	48
Phosphoric acid . . . . . (in combination with lime and magnesia).	1	3
Potash	1	3
Total	4	54

ammonia never enters the sewers. As this valuable substance is derived from the urine, it is evident, that nearly one-half is left to soak into the ground. We must therefore take a different calculation.

According to Liebig, 100,000 persons would give 24,440 tons of solid and liquid manure, containing about 3 per cent. of nitrogen, or 738 tons, sufficient to manure 50,000 acres. This, for 2½ millions, would give 608,800 tons of manure, and 18,450 tons of nitrogen—the quantity required for 1,250,000 acres of wheat land. The value of the 738 tons of nitrogen Liebig sets down at 12,000*l.*, which, for the above population, would give 300,000*l.* annually. There will then remain the earthy phosphates, the alkaline and neutral salts, together with the solid or organic matter, the whole of which is useful to plants. I am not aware of any accurate valuation for the whole of these ingredients: but in Flanders, the excreta of a man are valued at 1*l.* 17s., as we are informed by Mr. Chadwick,—say 1*l.* 15s. for the sake of round numbers. This for 2½ millions, would give an annual sum of 4,375,000*l.* But this sum, high as it may appear, is below the actual value; which arises, probably, from the fact that the matter in question, like all other, does not, and cannot, according to our present social arrangements and habits, contain the full proportion of liquid manure or urine—the most valuable part. A few figures will show this. If we calculate the quantity of urine for a single individual at 500 pounds in the year, this would give for 1,000 inhabitants 223 tons, which, according to Professor Johnson's valuation, at 10*l.* a ton, would amount to 2,230*l.** The total value, therefore, of the liquid manure, for a population of 2½ millions would be 5,575,000*l.* But human urine is more valuable than guano, as will be evident by a reference to the following table of Professors Hembstadt and Schübler.

TABLE, SHOWING THE RESULT OF EXPERIMENTS WITH DIFFERENT MANURES:—

	Quantity in proportion to seed.
No manure	3 times.
Herbage, grass, leaves, &c. . . .	5 „

* Lectures on Agricultural Chemistry.

	Quantity in proportion to seed.
Cow-dung	7 times
Pigeons' dung *	9 „
Horse-dung	10 „
Human urine	12 „
Sheep's dung	12 „
Human manure, or bullocks' blood .	14 „

It also gives the largest proportion of gluten, when applied to wheat crops, as shown by the next table :—

	Gluten.	Starch.	Bran, &c.
Human urine . . .	35·1	39·3	25·6
Bullocks' blood . .	34·2	41·3	25·5
Night-soil	33·1	41·4	25·5
Horse-dung . . .	13·7	61·6	24·7

A pound of wheat, therefore, raised from land manured with urine, would be nearly three times more nourishing than that produced on land manured with horse-dung—a circumstance of some importance in a social and economical point of view. This, however, is not all; for the liquid manure of London, if collected and applied to agricultural purposes, would produce, according to Professor Playfair's calculation,—that a pound of urine will yield a pound of wheat,—2,200,000 additional quarters of corn. If such would be the result with the employment of the liquid manure alone, we may calculate the value of the increased produce from the solid manure, not from wheat lands, but from other crops, at perhaps half—thus making a total for the liquid and solid manure of 8,365,500*l.*!†

* This would be very nearly the return for guano.

† It should be borne in mind, even supposing an exhaustless supply of guano could be obtained, that this latter is only applicable to corn lands, and that for other crops ordinary manure is required. In the present day, when steam has almost superseded horse power, human manure will become daily more and more valuable—particularly as it contains, with the exception of the silicate of potash, *all* the ingredients necessary for the growth and life of plants—the organic as well as the inorganic matter. An experiment, related by the late Mr. Smith, of Deanstone, proves this. He states that Mr. Thompson of Clitheroe, Lancashire, applied 8 tons of sewage

If, therefore, this matter were collected and applied to agricultural purposes, and if the same course were adopted with all the other towns in England, not only would an annual revenue be raised sufficient to pay the interest of the national debt, but the agriculturists of England would then be on a par with the manufacturers, for they might become exporters instead of importers. Not only would there be a cheap loaf, cheaply obtained, without having to send 10,000 miles for the manure, and leaving so much gold in its place; but increase of population, instead of being a curse, would then be a blessing, for the supply—at least of corn—would increase at the same rate. And yet it has been gravely proposed by a public Board, and the proposal has received the sanction of the Legislature, to throw this valuable matter into the sea; and this act of Vandalism has been committed in the middle of the nineteenth century, in what is termed an enlightened and scientific age, without so much as a particle of *direct* evidence having been produced to demonstrate the injurious qualities of the matter in question. Were the authorities in California or in Australia to order the produce of the gold-mines to be thrown into the sea, the act would not be more insane or less uncalled for. I trust, however, it is not too late to prevent the disgrace that would inevitably attach to the committal of so egregious a blunder; and at the same time to save the nation the loss that must accrue, if that plan be carried out; for it would then be difficult, if not impossible, to apply the contents of the sewers to agricultural purposes. The quantity of water required to carry the matter such a distance, would render its separation after difficult, if not impossible; while, if employed in a liquid form, it could only be along the line of the main sewer, not where it is most wanted, in the high and corn-growing districts. This is the opinion of the referees appointed by Sir B. Hall, who state that only about one-seventh part of the organic matter can be separated by any known economical process; but as a copious dilution of the sewage is necessary,

water to an acre of grass land; to another acre 15 tons of farm-yard manure; and to another 3 cwt. of guano. The result was that the grass raised by the sewage water exceeded the others in weight in the proportion of 15 tons to 8—being nearly double.

they add, to the health of the inhabitants of the metropolis, the sacrifice entailed by the dilution must be endured.* Here, however, we join issue, for it is to prevent this dilution and this loss that I am now contending. If my arguments and conclusions have any weight, not only will the contemplated measure be avoided, but even the present amount of dilution be lessened, so as to secure the whole of this valuable matter. Assuming that my facts and conclusions are valid, and that they will lead to the abandonment of the proposed plan, I shall proceed to give a short sketch of the way in which I think this matter ought to be collected, and applied to agricultural purposes.

It has been proposed, and the plan has been adopted in many instances, to apply the sewage water to agricultural districts by pipes, and by a system of irrigation. This, no doubt, is a very good plan for a small town, or for the immediate neighbourhood of a large one; but it would never answer for a populous town like London. There is, in my opinion, no other way in which the organic matter of such a town can be obtained, with a system of sewers, excepting by separating it from the fluid in which it is contained, and then transporting it, in a solid form, to the agricultural districts. This must be accomplished by filtration. It is necessary, however, for the filter to be at once mechanical and chemical in order to separate, not only the organic matter, but the soluble salts, the earthy phosphates, the ammonia, and the gaseous products of putrefaction. Several filters have been proposed for this purpose, and one by H. R. H. the Prince Consort: it is unnecessary, therefore, to describe it more fully. It is sufficient to know that all the ingredients contained in sewage water can be perfectly separated from the aqueous solution, provided only that the quantity of the latter be not too great.

These filters might be applied to the outlet of the present sewers, and would, no doubt, answer as a temporary expedient; but the separation of the different ingredients would not, it is probable, be perfect, for the drains of London receive not only the contents of the water-closets, but the surface water as well.

* Report of Messrs. Galton, Simpson, and Blackwell.—"Morning Post," Sept. 25, 1857.

It might be difficult, therefore, to adopt any system of filtration that would answer during heavy rains, when the quantity of water discharged is so great, and the current necessarily so strong: thus diluted, the complete separation of the organic matter would be somewhat problematical. The writers before quoted state that the average quantity of fluid, which passes off daily by the sewers is 431,000,000 gallons; from which they deduct 336,000,000 for rain, thus leaving 95,000,000 gallons for sewage. It would be desirable, therefore, if not necessary, to separate the surface water from the house refuse, which would require an alteration in the present sewers and drains, or, at least, an addition to them; for while they remained, and were reserved for the surface water, new ones might be made for the house refuse. This would be an additional outlay, but then it will be attended with other advantages besides the above. For instance, if the drains were separated, it would not be necessary as now, to send all the matter to the river: depôts might be established at any convenient spot, as, near the railroads. In this case, the district of Paddington might send all its refuse, nightly, to the lands laying along the line of the Great Western; and the district of St. Pancras and Islington by the Manchester and Great Northern. The South-Western, the Kentish and Brighton would convey away all the matter on the south side of the river.

In making this proposal, I have been influenced by the consideration that no ill result could arise by the accumulation of this matter, either to the inhabitants of London or to those of the country. As, however, I am ignorant if the facts and the arguments before advanced will have produced the same conviction in the minds of others as in my own, and as, in the determination of so important a question, all abstract opinions and theories ought to be thrown aside, I will only add, that should my conclusions be erroneous, and the opposite ones prove to be correct, the plan might, even then, be adopted; for all emanations from this matter may be prevented, both during its collection and during its conveyance to the fields. All objections, therefore, to the employment of this matter are at once done away with; for it would neither be a nuisance on the one hand, nor a cause of disease on the other. It is not my

intention to enter into any particulars on this point now, not knowing whether the suggestion will be adopted or not: I pledge myself, however, to prove the truth of the conclusion if called upon to do so by the proper authorities. As, however, it is easier to wear away the hardest rock by the dropping of water, than it is to change deep-rooted opinions and prejudices by arguments and reasoning, and as I know not what the decision on this subject may be, there is another suggestion that I wish to make. This is to collect the liquid manure, and to apply it separately. To this there can be no possible objection, particularly as regards that part of it which is now left to soak into the ground, and to become a nuisance. For this purpose, public places of accommodation should be erected *for both sexes*, the same as on the railroads, and in Paris, for the better classes—*les Cabinets d'Aisance*: this would probably save about one-half the liquid manure, while its collection and removal could be effected without any difficulty or annoyance. The plan is adopted in many Continental cities; a cart, with a pump attached to it, goes round at night, the hose is passed into the reservoir, and the contents pumped into the cart: it is the affair of two minutes. Having, however, ships at our command, we think it better to send 10,000 or 12,000 miles to Ichaboe and the Incas for an inferior article: it, no doubt, encourages commerce and our mercantile marine, although the Legislature, in its wisdom, has thought fit to abolish the Navigation Laws.

There is, also, another suggestion that I am disposed to make. Looking at the fact of the impossibility of rendering the water of the Thames pure, or of separating the alluvial and organic matter which it contains; and remembering, also, that the present supply is barely sufficient for the wants of the growing population of London, I think that other supplies should be sought. There are, however, few streams beyond the Thames, and these insufficient for the purpose, while they are all more or less polluted. Having no mountains in the vicinity of London, supplying exhaustless springs of pure and fresh water, we cannot follow the example of the ancient Romans, and bring our supply from a distant source; although it would not be necessary, in the present day, to construct

aqueducts—those magnificent works that attest the greatness of this fallen nation, more, perhaps, than any other.

The only sources to which the inhabitants of London can look for an additional supply of this necessary article of life are wells and rain water. The former have not been sufficiently attended to in my opinion, for there can be no doubt that a considerable supply could be obtained from this source, particularly if Artesian wells be formed. These would be most useful in the poorer and suburban districts, by affording a constant supply of pure and wholesome water for those who cannot afford to pay for the laying on of pipes; as, also, for the wayfaring and labouring man, who would not then be driven to the public-house to quench his thirst in summer. But it is to the heavens above that the inhabitants of London will probably have to look, at no distant period, for a part of their supply of water; and there is no better where the facilities for collecting rain-water are great. It was gravely proposed by the Board of Health, some years since, to collect the water on Bagshot-heath, and then convey it by pipes to London. How the water was to be collected, whether in a sail-cloth, or in a huge dish, or whether a sufficient quantity could have been collected to answer the intended purpose, are points that I need not enter into now, for the plan was wisely abandoned. The Board, however, in its simplicity, forgot that there was a much larger surface presented in London for the collection of rain-water—not an absorbing, but an impermeable surface; while, as this surface is raised above the level of the ground, no machinery would be required either to transport or to raise it—I mean the roofs of the houses. It is to this source that many towns—such as Cadiz and St. Thomas—are obliged to depend, the wells being brackish. If, therefore, the inhabitants of a warm climate, where rain only falls periodically and for certain months in the year, can make use of this water all the year round, there can be no reason why it should not be employed in a climate like that of London, and with a fall almost continuous. In that case the Thames water might be reserved for domestic purposes, for which it is alone fit. In the meantime I recommend every householder who is supplied with this water to filter it through a little charcoal and sand; for it is, perhaps, the only remedy, after all, for the

impurity of Thames water. By this simple expedient, provided only that the charcoal be recently prepared, and that it be renewed sufficiently often, not only Thames water, but even sewer water itself, might be taken with impunity, were an individual unfortunately driven to such an extremity.

Having thus discussed the merits of the plan intended to improve the sanitary condition of London, and having offered those suggestions which its inutility or its inapplicability appeared to demand, it now only remains to ascertain what measures are required in London for the same object—the prevention of disease. Independently of the general measures discussed in the last Part, there is one that is peculiarly applicable to this town, and this is the embankment of the Thames. It has been already stated that the elements productive of disease, or, in other words, malaria, are given out in greater abundance from the banks of rivers than in any other situation; if, therefore, we wish to render London as healthy as possible, this object, so desirable in many other points of view, should be carried out. To be effectual, however, the muddy surface must be covered, as far as low-water mark, with flag-stones, or some other impermeable substance; for it is the gaseous matter extricated from the soil, and not the emanations arising from the decomposing matter on the surface, that is productive of injury. As, however, the embankment, if made beyond the present line of wharfs, would have the effect of narrowing the stream and deepening the channel at the same time, the amount of surface to be covered would not be great.

In addition to the above, there is another object of paramount importance, in my estimation, to be effected by such a measure: this is, to guard against future injury from floods and inundations. Up to the present time, the injury from this cause has not been great; but, if my deductions be correct, such a catastrophe may occur, and will probably happen. In the work published by me on the Cause of Epidemics, it has been my object to show that certain physical phenomena are observed to prevail at epidemic periods to a much greater extent than at other times—such as great atmospherical vicissitudes, with severe drought, at one time, and excessive rain, with floods and inundations, at another. These effects, it is true, have not been

experienced to any extent in England as yet; but they have occurred in other countries—as in France, for instance; while we have had the atmospherical vicissitudes, and, during the past year, an unusual drought, which, as is well known, affected the water of the Thames. Should a flood occur to any considerable extent, the amount of property destroyed might be greater than the cost of the embankment, while it would then have to be done at all costs. As, however, I do not wish to be considered a croaker, or a prophet of evil, I shall not enlarge on this part of the subject, but refer those interested in such an inquiry to the work itself, where they will find the arguments and the facts on which these conclusions rest. I shall content myself with urging its adoption in a sanitary point of view, and as an effectual method of preventing disease, of which there can be little doubt after the facts adduced in the first Part of this treatise.

There is another subject which requires attention in a town supplied with sewers; this is the disturbance of the soil for the purpose of repairs. We have seen the ill effects of loosening the soil for the construction of new sewers, in the instances of Golden-square, Croydon, &c.; and we may hence infer what the results of the periodical digging down to the sewers, water, and gas pipes must be in a town like that of London. It is, in fact, this very operation which is injurious, and not the emanations from the sewers, when disease breaks out after obstructions in these conduits.* Whenever, therefore, old sewers are rebuilt, or new ones made, a subway, bricked in on each side and below, and arched over at the top, should be formed. In this tunnel may be placed the drains, the sewers, the gas-pipes, &c., so as to be accessible at all times for repairs, without disturbing the soil. Such a plan as this is necessarily expensive in the first instance, but it will be cheaper in the end; while it

* Such operations, as those of digging canals, for example, have always been dangerous and fatal to the workmen, even in temperate climates. This was particularly remarked during the formation of the canal, or artificial lake, at Versailles; but, having no record to refer to, I am unable to say how many lives were sacrificed before its completion. The mortality, however, was so great, that ordinary labourers could not be found, and the work was completed by soldiers, accustomed to mount the deadly breach at the word of command.

will be a matter of calculation how soon the outlay would be repaid, if the expense of each periodical operation be taken into the account.

It has been previously stated that ventilation is sometimes an agent in the prevention of disease, by dispersing the morbid exhalations given out from the surface. This result will be more likely to occur in a large city like London, and in the centre of the town, for we may infer that in such a situation the elements productive of disease will be extricated on the spot rather than beyond. Such an effect will be more probable if a river like the Thames runs through the heart of the city, for the reasons already stated. To remedy this evil, long and straight streets are required, running parallel and perpendicular to the river, and extending from one extremity of the suburbs to the other. At present, London is like a small suburban garden, laid out in circular walks, in order to make the most of the space by introducing the greatest number of *curves*. What is required, is a wide street running through the heart of London, as, for instance, from the end of Piccadilly to the commencement of Cheapside, so as to make a continuous line from Hyde Park to Whitechapel Church. If a straight line be drawn from the Regent-circus to the end of Cheapside, it will be seen that a new street might be formed without interfering with any important street, and by merely intersecting a few open spaces, as Leicester-square, Covent-garden, and Lincoln's-inn-fields. This would not only effect the object in view, but it would, at the same time, accomplish another purpose—it would bring the East and the West end of London into approximation.* If the plan I have proposed before be adopted—that of having a subway in every street, a railway or tramroad might be formed in this lower road, and be continued to any distance required, both east and west, so as to enable an individual to do what is now impossible, get from one end of London to the other without making a voyage round Cape Horn or the North

* "If the West-end of London could be brought to think of the East-end as of a city lying in the same latitude and longitude, we believe the City shopkeepers would find their account in the change." . . . . "It is highly desirable that the distinctions between East and West London should be obliterated as soon as possible."—*Times, Oct.* 15, 1853.

Pole. Such a street would be worthy of the capital of the British empire, while it would vie with, if it did not surpass, that so recently formed in Paris—the Rue Rivoli.

This, however, is not all or enough, in my opinion. Independently of this main artery, minor and lateral ones, extending in an opposite direction, should also be formed for the same object. One might be made in continuation of Bridge-street and Farringdon-street northwards and southwards, and another from Waterloo-bridge in the same directions. A third might be formed from Trafalgar-square to Camden Town, which would have the advantage of removing that national disgrace termed the National Gallery; or, if the nation be too poor to bear that loss, the new street might be continued from the lower part of Regent-street. As for the remainder of this famed street, it might be planted with trees, and be converted into what it really is—a labyrinth; and thus remain as an example to city architects, that, although curved lines are lines of beauty in a garden and in the human form, straight lines are the only lines of beauty, or of utility, in a town.

These are the only measures that I have to suggest for the prevention of disease; but, before closing this part of my treatise, I would wish to make a few remarks on another subject, which, although usually connected with the former, does not properly belong to it. I allude to hygiene. That the means which increase the physical powers of man are not those that render him less liable to attacks of disease, but rather the contrary, there is abundant evidence to show; but, then, it is the aim of medical science to effect both objects—preserve an individual in vigour of body and from attacks of disease. As this part of the subject is one that belongs, more especially, to a Board of Health, and one that the present Board professes to treat, I shall take the liberty of pointing out one or two matters that have been passed over or despised by this learned body, engaged, doubtless, in mere abstract pursuits—taking the level of a sewer, or measuring the quantity of matter collected daily by the scavengers and dustmen of London.

For instance, I do not infer, with the Board of Health, that the presence of carbonic acid in the air is injurious, but the contrary; still, I think it desirable that man should have a

regular and sufficient supply of oxygen, for, without it, he cannot preserve his bodily vigour. Were I, therefore, a member of the Board of Health, I should recommend the powers that be—the Commissioners of Woods and Forests—to plant shrubs and trees wherever practicable, and for the simple reason that plants absorb carbonic acid and give out oxygen. So, also, instead of writing prosy Reports about cesspools, and sewers, and all that nonsense, and trying to prove what daily experience will disprove, I should publish a few cheap tracts in order to teach the poor, that if they cannot go into the country, like their richer neighbours, they may yet bring the country into town, and inhale the fresh air in their own rooms. This can be accomplished by a very simple expedient, by the planting of a few flowers in their windows or yards—a benefit, moreover, that can be obtained at the cost of merely a few glasses of—Gin!

Then, again, there are certain agencies in constant operation, the effect of which, although not productive of ordinary diseases, is injurious, either by depressing the vital powers, or by causing certain morbid and even fatal results. One of these is the diffusion in the atmosphere of the gas used for illumination, by the leakage of the pipes: respecting which I have never heard a word uttered by the Board of Health. Compared to this the emanations from the sewers are as nothing, for we have from this source a direct and powerful poison diffused in the soil and air of London—situations in which it cannot, like the former, become absorbed by water and be carried away by the river to the sea. It penetrates into the sewers, however, and contributes in no small degree to the emanations that arise from these conduits. At an inquest held on the accident in the Pimlico sewers, Mr. Phillips stated, that "much of the blame, which was now attached to the sewers, was, he believed, due to the gas works; and that he had passed through miles in which the smell of the gas, which escaped from the mains, was very powerful." * He estimated that one-twentieth part of the gas manufactured passed through the pores of the piping in which it was conveyed. Any one who will take the trouble to stand over an opening in the streets,

* "Times," Oct. 19, 1849.

when the men dig down to repair a pipe or a sewer, may convince himself of the truth of this conclusion. We may, in fact, infer, that if modern London is destroyed, it will not be by fire above, but by fire beneath,—by an explosion of gas. There is but one remedy for the evil, and this is to oblige the Gas Companies to enclose the gas-pipe in one containing water, which would thus absorb the gas that escaped, and convey it away to the river, or other outlet.

It appears, by the interesting experiments of M. Tourdes, that there is no fear of an explosion when the air contains less than one-eleventh part of gas; but it is dangerous to life in much less proportions. With one-fifteenth part rabbits and pigeons were killed in a few minutes; and in an hour and a-half with only one-thirtieth. In less proportion a variety of morbid symptoms were produced, but death was not the immediate result.* This may, no doubt, occur even in this latter proportion, when individuals are exposed to the prolonged action of the gas, as when shut up in a sleeping room, or other confined spot, of which the above author gives a number of instances.

There is another evil, which falls under the peculiar cognizance of a Board of Health—placed as it were between the public and the profession on the one hand and the Government and the Legislature on the other—and for which it might have been supposed that they would have pointed out a remedy long since. I allude to the sale of poisons, and of quack medicines that contain poisonous ingredients. As is well known, it has now become the custom for mothers in the lower ranks of life to administer opium to their infants in order to keep them quiet during their absence at work; and this is done either directly in the form of tincture of opium, or in that of some preparation, as Daffy's Elixir, &c. This custom has now become so regular a one, and has extended itself so much, that, unless arrested, its results on the health and vigour of the rising generation in our large manufacturing towns will be most serious; and if the Board of Health be not aware of the fact, I would recommend them to send an Inspector to China

* Rélation Médicale des Asphyxies par le Gaz de l'éclairage.—Strasbourg.

to report on the effect of opium-smoking and opium-eating. Men of thirty, or twenty years of age, addicted to this vice, will there be found with all the appearance and all the decrepitude of advanced age, without either mental or bodily energy sufficient to carry on their daily avocations. What, then, must be the result of the daily administration of this poison to infants, who are so peculiarly susceptible to its noxious influences, as is well known to all medical practitioners. The cases, in fact, are not rare, in which children have died after the administration of ordinary and medicinal doses of opium ordered by medical practitioners; and, yet, we allow any female, in the lower ranks of life, to administer any quantity she pleases, with the chance of committing death, or producing worse evils; thus allowing infanticide in England, although we boast of having abolished it in India. And why, I would ask, has not a remedy been pointed out to the Legislature for this crying evil—this disgrace to a civilized nation—when it can be so readily found? I shall leave the Board of Health to answer the question.

Then, again, why has not the Government been informed of the evils that result from the sale of quack medicines in general—that reproach and stain on the national character. Can there, in fact, be any greater stain on a Government, or enlightened country, than to allow poisonous drugs to be sold daily to simple and credulous persons, and even to grant a licence to the vendor, for a small and paltry sum. Not only is opium thus allowed to be sold in poisonous and fatal doses, but other drugs, scarcely less noxious, are also distributed daily to thousands. If the Board of Health did not know how to grapple with this subject, why did it not send an Inspector to Paris to study the law there? and it might then, on his return, have recommended the Government to assimilate the law of England to the law of France—a law that is an encouragement to beneficial discoveries and real inventors: a prohibition to the impudent quack, the open and professed poisoner.

But it is not the vendors of poison, or quack medicines, that are alone guilty of these crimes; there are others who, although less culpable, also aid in the production of similar evil results; I mean the vendors of adulterated food. Here was another

legitimate subject for the Board of Health to have taken up; for, although it is not a scientific Board, it might have employed a scientific man, or analytical chemist, to obtain the necessary information for them. They allowed, however, a single individual to carry out this investigation, and to obtain, at his own cost, the necessary evidence to prove the extent to which this evil is carried. Notwithstanding, the Board of Health has hitherto done nothing to follow up the subject so philanthropically carried out by the editor of the "Lancet," although the ill-results of this practice are incalculable. This applies more particularly to the adulteration of gin and porter, which, as sold by the retail vendors, are little more than mixtures of poisonous drugs. Then, again, why is factitious milk allowed to be sold in London, when a pure and genuine fluid is alone vended in Paris; and when the means of detection are so easy and the remedy so apparent? Does the Board of Health think that a mixture of chalk and water will afford the requisite nourishment to an infant deprived of its mother's breast? Would not such a circumstance be more productive of disease and of death than all the emanations from all the cesspools in London? I should conclude so; and, as such, I recommend the Board of Health henceforth to leave the cesspools and the sewers to those to whom they more properly belong—the Commissioners of Sewers—and to look into the milk pails, the porter pots, and the gin bottles. This will not only be a more agreeable occupation for themselves, but a more profitable one as regards the public; for, where one person is injured by the emanations from the matter contained in the above receptacles, there are ninety and nine by the poisonous potations taken into the stomach, under the guise of food. I hope, however, the Board of Health will not be influenced by any feeling of delicacy in adopting the suggestions of an opponent, for, according to the good old adage, it is not only lawful, but praiseworthy, to receive advice from an enemy. Besides, the Board would hereafter find, that the advice comes from one of their best friends; as they would, by such a course, call down upon their heads the blessings of thousands, and, in particular, of that interesting class of Her Majesty's subjects—the babies. Their first accents of praise will, no doubt, be to lisp the name of their

benefactors, for giving them, in the absence of their natural fount, a wholesome and life-reviving liquid, instead of a poisonous draught; for a non-nutritious article given instead of food acts as potently as a poison. When that happy time arrives, the Board of Health will, perhaps, call to mind the humble individual who gives them this advice, and, holding out the right-hand of fellowship and of friendship, exclaim, in the words of King Acestes to Mentor and Telemachus, "*Nos ennemies deviennent nos amis fideles;*" and, in that hope and persuasion, I shall now take leave of my present opponents, and future friends.

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*** The Work entitled "The Antidotal Treatment of the Epidemic Cholera," has been translated into Spanish, French, and Italian, and published at Barcelona, Montpelier, and Messina. That on "The Efficacy of Carbonic acid gas, in the Diseases of Tropical Climates," has also been translated into Italian, and published at Messina.

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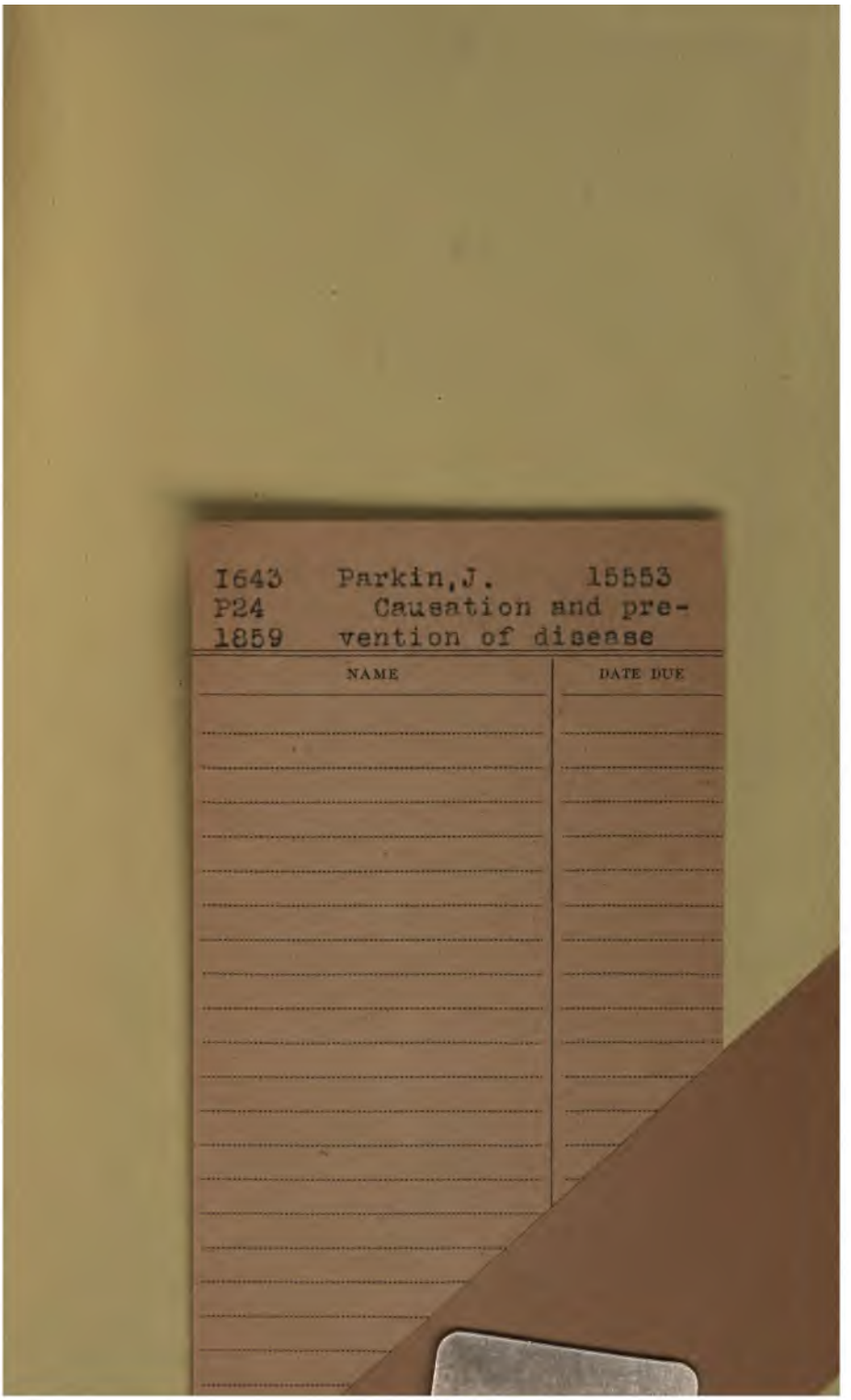
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